THE WEEK'S EVENTS

Shasta Contractor Ordered to Start

Execution of rail relocation contract permits work to go ahead on Shasta Dam in California

Contractors on the Shasta storage dam in California were ordered Sept. 6 by the Bureau of Reclamation to start work within 30 days on construction of the dam. This order followed within a few hours the completion of a contract between the bureau and the Southern Pacific Ry. arranging for relocation of the Southern Pacific main line tracks, which now go through the dam and reservoir site.

Pacific Constructors, Inc., was recently awarded the contract for construction of Shasta Dam on its bid of $35,939,000. This bid price does not cover materials such as cement, steel, metal work and machinery; these will be bought under separate contract.

Shasta Dam, 3,500 ft. long and 560 ft. high, will contain 5,500,000 cu.yd. of concrete. The contractor is allowed 2,000 calendar days to complete the project. The contractor has already executed a guarantee bond of $2,000,000, a performance bond of $5,000,000, and labor payment bond of $2,500,000. A contractor's field office has been opened in Redding, and about 140 men are employed in preliminary work.

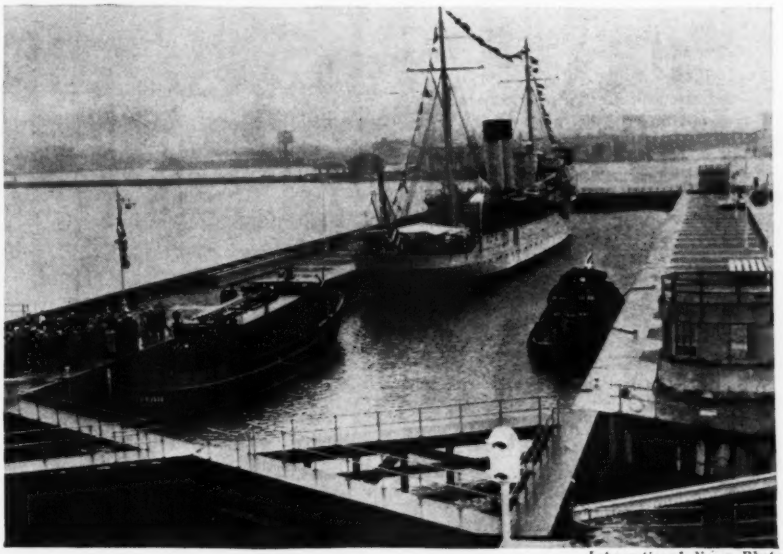
Shasta Dam, largest item in the $170,000,000 Central Valley project in California, will create a reservoir with a storage capacity of 4,500,000 acre-ft., storing waters of the Sacramento, Pit and McCloud rivers. The reservoir will improve navigation and control floods in the Sacramento valley, provide irrigation in the Sacramento and San Joaquin valleys, correct the salt invasion of the Sacramento-San Joaquin delta and generate electric power.

The contract for relocation of the Southern Pacific lines provides that railway traffic will first be diverted through a tunnel now under construction under the site of the dam. This will later be used for river diversion.

The permanent relocated line of the Southern Pacific will take about two years to build. Under the contract, the Bureau of Reclamation will do the grading for the line, will furnish all track fill, and will also construct the Pit River bridge; title to this bridge will remain with the United States, but the railroad will be given a permanent easement.

The Southern Pacific will lay the ties and rails and install the signal system, being paid for his work by the United States on a cost plus basis.

(*Continued on page 315*)



International News Photo

CHICAGO CONTROL LOCK DEDICATED

CONTROL of the flow of the Chicago River, which diverts Lake Michigan water into the Illinois valley, was transferred to the lake end of the river Sept. 7 with the dedication of the Chicago Sanitary District's new $2,750,000 lock.

The lock was built as a part of the general program of sewage treatment works made necessary by the Supreme Court's decision limiting lake diversion to 1,500 sec.-ft. after the end of the year. It will prevent the flow of water during heavy rainstorms from carrying sewer overflows into Lake Michigan, averting the chance of polluting the city's water supply.

The triangular shaped gates are unusual in that the water levels on the two sides are to be equalized by opening the gates slowly, rather than by the usual method of filling through valves and tunnels. The gates can operate against a head of 8 ft. in either direction.

The lock and its guard walls are built of sheet steel piling cells filled with crushed rock and capped with reinforced concrete.

The lock was designed by the engineering department of the Sanitary District of Chicago of which W. H. Trinkaus is chief engineer. The project was financed by PWA, Joshua D'Esposito was resident engineer.

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Niagara Sewage Plant Passes First Trials

The new sewage treatment plant at Niagara Falls, N. Y., has successfully passed its mechanical trials, Lawrence G. Rice, resident engineer, reported to City Manager Robbins Sept. 3. A final test on one of the plant's two incinerators indicated that a mixture of coke and sludge can be burned without dewatering. Dewatering machinery originally installed in the plant was removed when its performance proved unsatisfactory (*ENR*, Aug. 18, 1938, p. 188).

Rice reported that a final test run on one of the plant's six screen filtering units, with coke used as a filtering agent, showed a capacity ranging from 7 to 12 m.g.d. per unit, with solids removal ranging from 15 to 38 per cent.

A final 30-day performance test, expected to start about Nov. 1, must be completed before the plant will be accepted by the city.

Third of States At PWA Limit

WPA highway improvement program in Georgia to cost $53,000,000 if completed

As the Public Works Administration continued to issue daily lists of new non-federal allotments, Administrator Ickes indicated that about one-third of the states have now reached the point at which they have received their "fair shares" of the current pump-priming funds. He declined, however, to make public a list of these states.

Ickes also stood firmly on the announced deadline of Oct. 1 for bond elections on projects to be financed under the current program. Considerable pressure has been brought to relax the rule in certain specific instances. The administrator stated, however, that under the terms of the law he is directed to put his funds into active projects and that it would be unfair to reserve money for projects subject to the uncertainty of bond elections when there are applications on hand for other undertakings not carrying this hazard.

Large projects

A number of large projects on which applications for PWA financing have been filed are now on the verge of approval or disapproval. These include the Wisconsin water conservation and power project, which the administrator indicates is probably too big to fit under the state's quota; the Maryland bridge program, to which the New York regional office has given its approval as regards engineering features, but which has yet to pass PWA's legal and financial scrutiny; Harrisburg-Pittsburgh toll highway, already approved by PWA but held up pending the adjustment of details of a Reconstruction Finance Corp. loan; and New York City's Battery tunnel, now under consideration by RFC.

Belief that the big Wisconsin hydro-electric program would not be approved was generated in Wisconsin by Ickes' action in releasing $10,000,000 of smaller PWA projects there. All Wisconsin projects have been held up since July 26 pending a decision on whether the major part of the state's share of PWA money should be put into the one large hydro-electric project.

Georgia road program

The administration's recently-announced intention to promote purchasing power in the South by providing part-time work for low-income agricultural workers was inaugurated last week with the approval of a $53,000,000 highway improvement plan in the state of Georgia. Similar announcements imminent in respect to other southern states.

The announcement should not be misunderstood: It does not involve the actual grant of this amount nor the completion of all projects approved. It merely adds to the list of approved projects to which WPA labor in Georgia may be assigned a large number of road improvement jobs. How many of these actually come under construction depends upon the action of local sponsors and the amount of money made available for WPA payrolls in that state.

WPA spends fast

The relative speed with which PWA and WPA can get pump-priming funds into circulation is indicated by an unofficial survey of actual expenditures by the two agencies since the start of the fiscal year on July 1, 1938. In round numbers, WPA has spent $413,000,000 of its $1,425,000,000, while PWA has only disbursed some $5,000,000 of its $750,000,000 available for grants. WPA funds go directly into weekly payrolls on work done predominately under force accounts, while PWA makes no actual payments until formal projects have been approved, contracts awarded, and actual construction finally gets started.

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Big Subway Contracts Let in New York

Contract action on more than eleven million dollars worth of subway construction on New York City's Independent Subway System was taken last week by the city. The Board of Transportation awarded the contract for construction of a section of the Fulton St. line along Pitkin Ave. in Brooklyn, to the George H. Flinn Corp. on its low bid of $4,017,000.

On the same day executed contracts, approved by the Board of Estimate, were delivered to Rusciano & Son, Inc., for a $1,931,000 section along Fulton St. and through a private right-of-way; and to the George H. Flinn Corp. for another section along Pennsylvania and Pitkin Aves., which it is to build at a price of $5,220,000.

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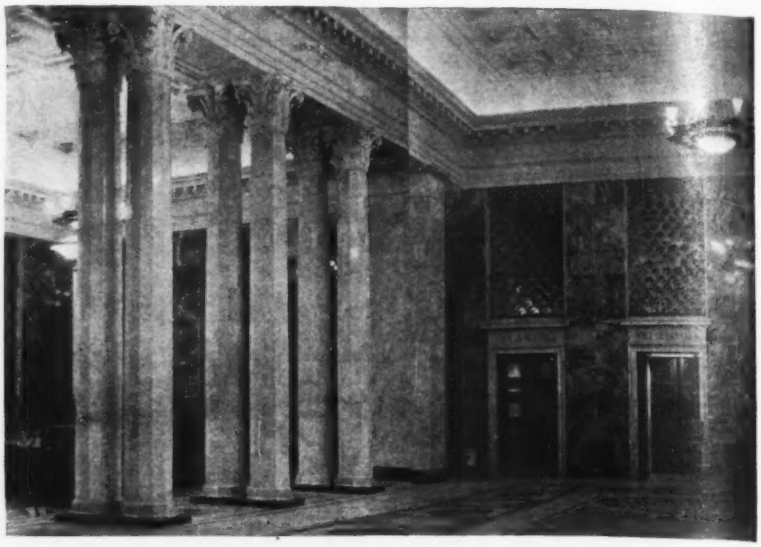
Pennsylvania Plans Big School Program

Governor Earle of Pennsylvania on Sept. 9 signed a bill providing for a $75,000,000 program of school building construction throughout the state. Intended to be carried out under the auspices of the General State Authority, the program is contingent upon PWA approval of grants to carry 45 per cent of the cost of the program. Applications covering 362 schools have already been submitted to PWA, and the entire program calls for 1000 applications for federal aid.

The remaining 55 per cent of the cost will be financed by the General State Authority through the sale of bonds. The bonds will be retired by rentals paid to the authority by local school districts.



Sovfoto

BELIEVE IT OR NOT—A SUBWAY

THE NEW Gorky branch of the Moscow subway, U.S.S.R., soon to be opened, continues the Soviet practice of installing palatial subway stations. Shown above is the entrance hall at the Bylorussian station.

NEW HOUSING LOAN CONTRACTS

City	Dwelling Units	Cost Per Unit	Total Estimated Cost of Project	Federal Loan
Mobile, Ala.	398	$2,885	$1,834,000	$1,649,000
Oakland, Calif.	556	2,733	2,880,000	2,591,000
Kokomo, Ind.	175	2,815	705,000	634,000
Vincennes, Ind.	83	3,078	353,000	317,000
Covington, Ky.	431	3,116	2,165,000	1,947,000
New Orleans, La.	1,819	3,372	10,924,000	9,830,000
Annapolis, Md.	100	3,096	532,000	478,000
Baltimore, Md.	1,102	3,312	5,529,000	4,975,000
Elizabeth, N. J.	423	3,339	2,244,000	2,019,000
Newark, N. J.	1,168	3,427	6,597,000	5,936,000
Buffalo, N. Y.	172	3,309	913,000	821,000
Utica, N. Y.	212	3,224	1,000,000	900,000
Yonkers, N. Y.	545	3,512	3,307,000	2,976,000
Cincinnati, Ohio	1,500	3,407	7,891,000	7,101,000
Chester, Pa.	396	3,282	2,165,000	1,948,000
Corpus Christi, Texas	242	2,384	942,000	846,000
El Paso, Texas	318	2,552	1,345,000	1,210,000
Huntington, W. Va.	500	3,158	2,336,000	2,101,000
Total	10,140		$53,662,000	$48,279,000

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week, $53,569,000, are 13 per cent higher than the volume for the corresponding 1937 week. This is the ninth successive week in which construction awards have exceeded their 1937 values.

Cumulative construction total for 37 weeks of 1938, $1,872,779,000, is 4.0 per cent above the $1,801,337,000 for the corresponding period last year.

Public construction is 71 per cent above the week a year ago, due to the high volume of highways and public buildings. Private awards are 61 per cent lower than a year ago.

Highways and public buildings record the outstanding gains over the 1937 week. Their combined volume totals $28,300,000, 53 per cent of the current week's volume. Earthwork and drainage, and unclassified construction are also above last year.

New construction capital for the week totals $164,023,000, a drop of 51 per cent from the $335,107,000 for the week last year. This week's financing includes $63,331,000 in PWA allotments for non-federal projects, $48,279,000 in USHA loans to 18 cities, $40,714,000 in corporate security issues, $11,043,000 in state and municipal bonds, $500,000, an RFC loan for municipal projects, and $156,000 in PWA allotments for federal projects.

Construction capital for 1938 to date totals $2,992,067,000, an increase of 52 per cent over the $1,960,521,000 for the 37-week period a year ago.

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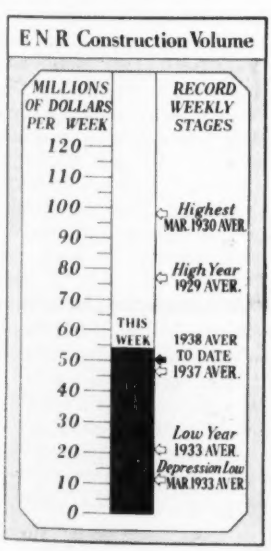

CONTRACTS

(Thousands of dollars)

	Week Ending Sept. 16 1937	Sept. 8 1938	Sept. 15 1938
Federal	$5,528	$7,001	$9,304
State & Municipal	21,038	29,011	36,113
Total public	$26,566	$36,012	$45,417
Total private	20,781	16,444	8,152
TOTALS	$47,347	$52,456	$53,569
Cumulative 1938 (37 weeks)			$1,872,779
Cumulative 1937 (37 weeks)			$1,801,337

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 37 Wk.	1938 37 Wk.
NON-FEDERAL	$1,214,298	$1,847,969
Corporate securities	440,326	325,577
State & Mun. bonds	387,214	418,132
PWA loans, grants	156,819	589,019
RFC loans	29,939	97,391
U.S.H.A. loans	.....	202,807
R.E.A. loans	.....	13,543
Federal Aid-Highways	200,000	201,500
FEDERAL	$746,223	$1,144,098
TOTAL CAPITAL	$1,960,521	$2,992,067

FHA MORTGAGES

	Cumulative 1937 36 Wk.	1938 36 Wk.
Mortg. selected for appraisal	$452,301	$693,873

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Sept.	232.70	111.86
Building Cost	Sept.	194.80	105.30
Volume	Aug.	218	96

Eighteen Cities Get Housing Money

Loan contracts for thirty projects bring total USHA loans past $200,000,000

Loan contracts totaling $48,279,000 for construction by local housing authorities of low-cost housing projects were approved Sept. 7 by the President. Approval of these thirty projects in eighteen cities brought the total amount which the U. S. Housing Authority has definitely obligated itself to lend to $202,807,000.

In addition, $316,466,000 has been informally earmarked for 111 cities.

The 30 new projects will provide about 10,140 dwelling units and will bring the total number of dwelling units provided for to 40,636.

Of the 18 cities receiving loans, New Orleans, Baltimore and Buffalo have received previous contracts; the total loans available for these cities are now $18,241,000, $21,591,000 and $4,464,000 respectively.

In the attached table, the cost per unit includes only the cost of construction of actual dwelling facilities. The total estimated project cost includes also land, non-dwelling facilities, and architectural and overhead charges. Federal loans cover 90 per cent of the actual cost. They are made at an interest rate of 3¼ per cent and are to be amortized over a 60-year period.

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Morrison-Knudson Is Low On Fort Supply Dam

Fourteen bids were received by the Little Rock district engineer of the U. S. Engineers Aug. 30 for construction of the first unit of the Fort Supply flood control project in Oklahoma. The low bid, covering construction of the earth portion of the Fort Supply dam, was made by Morrison-Knudson Co. of Boise, Idaho, and W. C. Cole of San Diego, jointly, for $1,554,000.

The work involves excavation of 2,450,000 cu.yd. of shale at the spillway site on the north bank of Wolf Creek and placing the earth in a compacted fill in an earth dam on the south bank. In addition, 1,200,000 cu.yd. of sand is to be placed in the pervious portion of the dam.

The Fort Supply dam on Wolf Creek, a tributary of the North Canadian River about 135 miles from Oklahoma City, is a $5,000,000 flood control dam being built entirely with federal funds.

Last March Oklahoma City voters rejected a proposal that the city raise $2,357,000 and obtain the use, for municipal water supply, of an additional 100,000 acre-ft. of storage.

Flood Damage Reaches Quarter Million

Small dams, buildings and highways wrecked by swollen Colorado creeks

A three day rainfall of high intensity along the front range of the Rocky Mountains, extending from the Wyoming state line southward to Colorado Springs, a distance of about 150 miles, caused flood damage Sept. 3 estimated at a quarter million dollars including crop losses. The rain-swollen creeks took a toll of six lives.

Morrison, a small town situated on the floor of a canyon about fifteen miles from Denver, suffered the most damage. The town is built just below the juncture of Bear and Vernon Creeks. At this time of the year normal flow of these two creeks is about 100 sec. ft., but the estimated flow at the peak flood Sept. 2 was 8,000 sec.-ft.

Just above Morrison a large culvert bridge became clogged with mud and debris and retained the flow of Vernon Creek until the pressure took out the bridge, releasing a great quantity of water. Water rose in the town to a height of eight feet, sweeping away small buildings and toppling over others. In this vicinity five lives were lost.

The damage to highways will amount to about $40,000. Plans are being made to relocate the roads at a higher elevation to avoid future destruction; the cost of this construction would be about a quarter million dollars, and an attempt is being made to secure a federal grant.

At Eldorado Springs, a resort thirty miles northwest of Denver, situated in a precipitous canyon, a flow of 7,000 second feet ruined a dancing pavilion and cottages along South Boulder Creek. The ordinary flow is 75 second feet.

It was feared for a time that the Buckhorn Dam in the Big Thompson Canyon eight miles above Loveland was breaking; orders were given to evacuate the town of Erie, where the water had already risen in the streets. Preparations were also being made to remove the inhabitants of Loveland, and a crew of men was rushed to the dam to strengthen the structure, but it withstood the test.

Nearly all the irrigation canal headworks along the Big Thompson were destroyed. The heavy rains in the canyon caused a landslide over the highway and traffic was blocked for half a day.

Near Kersey the usual flow at this time of the year is 300 second feet, but augmented by the numerous tributaries, the flow is increased to 17,500 second feet. Three small diversion dams in the vicinity of Sterling are practically a complete loss. One of them had to be dynamited to save the main dam on the South Platte.

Cherry Creek, flowing through Denver, reached bank full proportions. During the past few years the channel has been straightened and riprapped, and retaining walls have been constructed about ten feet high.

The recently completed Sullavan Dam, 25 miles above Denver, is an automatic flood control regulator. The flood provided the first thorough test the dam has received, and the structure proved adequate for this size flood, releasing only the amount of water the channel could safely carry.

No flood in Colorado's history has produced so much storage water. Over 65,000 acre feet have been stored in the reservoirs, and on a basis of $2.00 per acre foot the value amounts to $130,000.

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Construction Near On Chicago Filter

Bids on the first construction work for the South Side filter plant will be received by the City of Chicago on Sept. 19. The first unit is a breakwater 3,000 ft. out in Lake Michigan to protect the filter plant operation. The filter plant itself will be built behind a U-shaped cofferdam.

Bids are called for on three alternate types of breakwater. The first alternate is a rubble mound 2,660 ft. long and 100 ft. wide at the bottom. The second will consist of steel sheet pile cells 35-ft. wide at the belly of the cell; the breakwater on this alternate would be 2,696 ft. long. Bids are also asked on a combination of the two types, consisting of a rubble mound for 1,456 ft. on rock bottom and steel cells for 1,180 ft.

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Philadelphia Told To Treat Sewage

The city of Philadelphia must take steps to treat its sewage before September 22 or the full force of the Pennsylvania Stream Pollution Act will be applied against it for pollution of the Delaware and Schuylkill Rivers. The city council was so notified by the state attorney-general's office on August 30.

"The full force of the Pure Streams Act," the city was told, "will be invoked to protect the health and welfare of the people of Philadelphia and to compel the city to construct and complete a sewage disposal plant."

Texas Utilities Offer To Sell Out Property

The Texas Power & Light Co., an Electric Bond & Share affiliate, offered on Sept. 6 to sell all its properties and contracts in sixteen counties in Texas to the Lower Colorado River Authority. The authority, which is building a number of multiple-purpose flood control and power dams on the Colorado River, is preparing to sell power to municipally-owned distribution systems and cooperatives.

The power company offered to sell on the basis of its actual cash investment in the territory.

Last March the utility offered to purchase the entire power output of the authority, but the authority held that it could only sell to public bodies and cooperatives.

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Generation Planned At Debris Dam

The use of a proposed federal debris dam on the Yuba River in California for the generation of power by a private power company is provided for in a preliminary permit issued by the Federal Power Commission to the Sacramento Valley Utility Co., the commission announced Sept. 6.

The permit, limited to a period of 18 months, covers installation by the Sacramento Valley Utility Co. of a 12,000-kw. power plant about 1,000 ft. below the proposed Upper Narrows Debris Storage Dam in Nevada and Yuba counties. The proposed debris storage dam and reservoir was authorized by Congress in the River and Harbor Act of 1935.

The commission found that the proposed power plant will be necessary and convenient for the purpose of utilizing surplus water from the proposed government dam. The commission's order provides that a final license, if issued, may be subject to the provision that the United States reserves the right to fill the reservoir with debris to such height and at such a rate as it may desire. The operations of the power company, moreover, as regards control of the river water, might be subject to such rules and regulations as might be prescribed by the Secretary of War.

The commission's order further provides "that a license, if issued, shall be for such limited period of time and contain such special terms and conditions . . . as may be necessary to protect . . . the development and utilization of the water resources of the Yuba River . . . by the Narrows dam and reservoir unit of the state water plan . . ."

Structural Paper Wins Major Award

Second prize in Lincoln Arc Welding contest goes to British structural engineer

The second prize award in the $200,000 contest for papers on applications of arc welding which was sponsored by the James F. Lincoln Arc Welding Foundation of Cleveland, went to Anant H. Pandya and R. J. Fowler, engineers for Diagrid Structures, Ltd. of London, England. They received a prize of $11,397 for their paper, "The All Welded Grid Applied to Plane and Spatial Structures." This paper, according to the Lincoln Foundation, "will doubtless usher in a new era in the design of framing for roofs and floors of buildings. Eliminating trusses and columns except at corners of bays, the design makes a saving of $60,000,000 available to industry. . ."

The grand award of the contest, $13,941, went to Mr. and Mrs. A. E. Gibson, president and stockholder of the Wellman Engineering Co. of Cleveland. Their paper is a treatise on the elements required to assure the business and technical success of users of welding.

The James F. Lincoln Arc Welding Foundation, sponsor of the contest, is an organization set up last year by the Lincoln Electric Co., in honor of its president, to encourage scientific study of arc welding. The contest was announced in February, 1937. The papers received were judged by a jury composed of 31 engineering authorities from universities and colleges.

In addition to the major awards of the contest, awards were made in a considerable number of classifications and sub-classifications.

Winners of the major awards in the structural classification in addition to the two British engineers included Robert V. Proctor, general manager and chief engineer of the Commercial Shearing & Stamping Co. of Youngstown, Ohio, for a paper, "Arc Weldel Tunnel Liner." He received $2,747. Howard E. Boath and Charles MacNish, of the Corps of Engineers, received $1,526 jointly for their paper, "Welding Consciousness in the Structural Steel Industry." A joint award of $1,526 went to Robert S. Treat and John F. Willis of the Connecticut state highway department for a paper, "Two Span Rigid Frames for Grade Separation."

Winners in certain of the structural sub-classifications were as follows:

Building Prize

Prize	*Winner*	*Employer*
$508	J. G. Esagaris	Erie Steel Construction Co.
305	Gilbert H. Atwood	Dravo Corporation.
203	R. Sherman	Messrs. Steel Ceilings, Ltd., Hayes, Middlesex, Eng.
152	W. Cory Hale	Roy A. Benjamin, Jacksonville architect.

Bridges

$508	B. M. Shimkin and G. A. Sedgwick	California Bridge Dept.
305	Stanley G. Reiff	General Construction Co., Omaha.
253	Thomas H. Gardner	Florida East Coast Railways.
152	John M. Heffelfinger and H. T. Borton	City of Cleveland.

WIND TUNNEL DEDICATED

CAPABLE of creating an air speed of 400 miles an hour and air pressures ranging from ¼ to 4 atmospheres, this new wind tunnel at Massachusetts Institute of Technology was dedicated Sept. 12 as a memorial to the Wright Brothers. Orville Wright had planned to be present, but he was prevented by illness.

The wind tunnel consists of a closed welded cylindrical steel circuit in which a 13-ft. variable pitch propeller powered by a 2,000-hp. electric motor moves the air at high speed.

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Power Company to Build Big Steam Plant

The Niagara Hudson Power Corp., has announced purchase of an 80,000-kw. steam turbine generator for installation in its Oswego, N. Y. plant.

The turbine generator will be built by General Electric and the boiler by Babcock & Wilcox Co. The entire plant, costing $9,500,000, will be installed in the new steam electric station of the Central New York Power Corp. at Oswego. Operating on steam at a pressure of 1,250 lb. per sq.in., the plant is expected to produce a kilowatt-hour of electric energy from the combustion of 0.85 lb. of coal at full load.

Roadside Protection On Ontario Roads

Canadian Good Roads Association told commercial structures are forbidden on new freeways

The Ontario department of highways is prohibiting the establishment of commercial enterprises along the sides of the new express highways which the province is now building. T. B. McQuesten, Ontario minister of highways, so stated in a paper before the annual convention of the Canadian Good Roads Association at Muskoka Lake Sept. 5-8. He said that of the express highways 100 miles are now under construction and 40 miles are completed.

The more than 300 delegates at the convention elected McQuesten as president for the coming year.

The convention adopted resolutions favoring the Ontario practice described in McQuesten's paper and also favoring bypassing of congested areas.

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Toll Road Planned Near New York

Westchester County, suburban area immediately north of New York City, deviated on Sept. 12 from the practice it has long followed in developing a $65,000,000 parkway system when the county board of supervisors voted to finance improvements to the Cross County Parkway by collection of tolls.

The supervisors decided to seek a $1,800,000 loan from the Reconstruction Finance Corp. Part of the money would be used to build a toll bridge between Yonkers and Mount Vernon, the loan to be retired from tolls.

The loan to be sought would cover the cost of the new bridge and of a half-mile extension of the parkway to connect with the Sawmill River Parkway.

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Shasta Dam to Start

Continued from page 311

After the railroad has constructed the new line, it has a right to demand payment from the government of not more than $350,000 over a period of five years for unusual maintenance costs actually incurred resulting from slippage, settlement, or similar troubles along the right-of-way.

The relocated line will be single track, although the Bureau of Reclamation is required to construct foundations of certain structures in such a manner that double tracking may be accomplished later.

Air Surveys Need High Speed Planes

Photogrammetry society discusses nature of ideal airplane for photo surveys

Over a hundred eastern aerial mapping men discussed technical problems and inspected equipment for their vocation at the two-day meeting of the American Society of Photogrammetry in New York Sept. 8–9.

Following a discourse on the use of oxygen in high-altitude flying, by Dr. W. R. Lovelace of the Mayo Clinic, Rochester, Minn., and one from the standpoint of the photographer on the future possibilities in aerial photography from W. B. Rayton, Bausch & Lomb Optical Co., Rochester, N. Y., Jack Peace, of Fairchild Aerial Camera Corporation, presented the consensus of experts on the factors which would make up the ideal airplane for photogrammetry. The ideal plane for this purpose must have a speed of around 200 m.p.h. and a climb of 1,000 ft. per min. As wider angle lenses are put into use, the speed should rise, Peace stated, because of the longer interval between photographic exposures. The fast climb is necessary because efficiency demands that a maximum of working time be devoted to photography at a good height, such as 20,000 ft. The ideal plane must combine its speed with a low landing speed because of adverse flying field conditions frequently encountered. Next, crew comfort must be considered. Temperature, draft, vibration and sound must be cared for.

James Terry Duce, of the Texas Petroleum Co., told of the use of aerial photography by petroleum geologists, and Russell Van Nest Black, New Jersey town planner, described the use of the airplane photograph in regional planning. Used on a small scale, aerial maps can be used for quick quantitative checking of features of land use, such as blighted areas. Larger scale aerial maps are used in reconnaissance for highways and other public works.

The outstanding piece of equipment on display at the meeting was a new camera, built by Fairchild, said to embody the features of the "ideal" camera, as they probably will be set up by the society. Specifications of such an instrument are being written in answer to a demand by photogrammetists for a precision camera—one which will get the best all-around picture the first time, and thus avoid necessity for duplication for various purposes.

Vilhjalmur Stefansson, famous explorer, gave an address at the meeting banquet, and members of the Society visited the Fairchild plant.

N. Y. Bridge Authority Superintendent Dies

Lucius S. Hulburd, superintendent of bridges for the New York State Bridge Authority, died at Poughkeepsie Sept. 6 at the age of 59. Hulburd was in charge of operations of the Mid-Hudson Bridge at Poughkeepsie and the Rip Van Winkle Bridge at Catskill. A graduate of Cornell University in 1903, Hulburd immediately entered the service of New York State as a leveler in the engineering department, rising through several posts, including important work on the barge canal. He was engineering representative of the state during the construction of the Mid-Hudson Bridge and became operating superintendent in 1928.

THOMAS H. TUTWILER, president emeritus and director of the Memphis Power and Light Co., died there Sept. 3 at the age of 72. He retired from active duties as president of the power company in 1930. Tutwiler began his engineering practice in 1882 as a rodman for the Richmond & Allegheny Railroad. He served for a year or two with a number of railroads in the South and Southwest on location, bridge, and levee construction work and in 1893 joined the New Orleans Traction Co., rising from the rank of first assistant engineer to that of chief engineer. Seven years later he became superintendent of street railroad construction at Birmingham for Ford, Bacon & Davis. In 1906, Tutwiler was made president and general manager of the Memphis Street Railroad Co., and became president of the Memphis Power & Light in 1923.

SIR BASIL MOTT, an engineer who had a large part in the construction of the London subway system, died in London Sept. 7 at the age of 78.

JAMES W. PHILLIPS, former chief of the grade crossing division of the Philadelphia Bureau of Surveys, died Aug. 25 in New Ipswich, N. H., at the age of 78. At the time of his retirement in 1932 he had served the city as a civil engineer for 43 years.

HERMAN DAVIDSON, president of Albert & Davidson Pipe Co. of Brooklyn, died Sept. 1.

CHARLES A. RUGGLES, retired structural engineer of New York City, died in Rye, N. Y., Sept. 6 at the age of 68. Ruggles was formerly manager of the New York office of Brown Ketcham Iron Works of Indianapolis.

L. J. SABIN, designer and manufacturer of welders gloves used extensively on construction operations, died Sept. 1 at Youngstown, Ohio, at the age of 69.

Planners Discuss Underground Cities

Tropical housing and planning for recreation are other subjects at Mexico City conference

By Arthur V. Sheridan

The planning of underground structure was the most sensational of the topics discussed at the International Housing and Town Planning Congress held in Mexico City, August 13-21. Despite continued statements to the effect that the topic was not intended to be concerned with military affairs, the discussion resolved itself largely into a consideration of the necessity for protecting and utilizing sub-surface structures in time of war. The subject was discussed by Ezequiel Ordonez, George Camp, and Warren Vinton, economic adviser to the U. S. Housing Authority.

About 470 people interested in the social, economic, and physical aspects of town planning attended the conference. About half were representatives from the various states and governmental agencies of Mexico. The remaining number was made up of accredited delegates from the United States, Europe, South America, and other parts of the world.

In addition to underground planning, the subjects considered were housing in tropical and sub-tropical countries, and planning for recreation and the use of leisure time.

The discussions of tropical housing delved in some detail into conditions prevailing in African and Asiatic areas, where the destructive forces of nature and the lack of adequate sanitary conditions present unique problems. Bleecker Markett, president of the National Association of Housing Officials and Francisco Carrera, Justiz of the University of Havana, were the principal speakers at the session.

"Planning, recreation and the use of leisure time" was discussed by Morton L. Wallerstein, president of the American Society of Planning Officials, John Ihlder, executive officer of the Alley Dwelling Authority, and Charles E. Merriam, head of the Department of Political Science at Chicago University.

The formal sessions of the congress were presided over by George L. Pepler of London, president of the International Federation for Housing and Town Planning, the organization sponsoring the congress. President Lazaro Cardenas of Mexico was honorary president. Chairman and president of the organizing committee was Carlos Conterars, a Mexican architect.

The next session of the congress will be held at Stockholm in 1939.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

A Native Testifies

Sir: Having been born and raised in Virginia and spent considerable of my adult life there in road work, I feel as though I am qualified to pass judgment on the article on Virginia's earth roads (*ENR* Sept. 1, 1938), particularly the historical facts with reference to taking over the old county road systems. I want to say that "Judge" Hill did a grand job outlining it concisely, interestingly and, above all, very accurately.

W. R. MACATEE
District Engineer, Asphalt Institute
Cincinnati, O., Sept. 3, 1938

Land Fills: Pro and Con

The following comments refer to the article, Land Fills for Refuse Disposal, by E. J. Cleary, which appeared in the Sept. 1 issue, p. 270.—EDITOR

Sir: I have read with great interest the article on our land fill practice, and it occurs to me that a few additional comments might be made.

During the past three years, the WPA through its mosquito control project has spent $13,099,712, and the city spent substantial sums in years prior thereto. Had New York City engaged in the practice of using the present system of land-fill years ago, many millions of dollars would have been saved up to the present time, to say nothing of the thousands of acres of reclaimed land that could be put to good use.

Rats have been the indirect cause of the death of more human beings than have been caused by all the combined wars of history. Rats live, thrive, breed and multiply in places where unsanitary conditions exist, consequently the old system of filling in swamp land and other land depressions created happy-hunting-grounds for, not only these rodents, but also for mosquitoes, flies and other disease-bearing pests. Since the adoption of our new land-fill system we deprive these pests of their places for breeding.

Regarding public reaction and complaints on the new methods of land-fill for refuse disposal: Out of the several locations where we are operating, we have had complaints from only two, and these during the warm months of June, July and August. We are constantly improving our system of handling these fills, and I now feel sure that we will be able to carry on these operations in such a manner as to give no reason for complaints from the people living in the vicinity.

On p. 271, par. 3, the article states: "Part of the material taken out is spread over the exposed surface of refuse to cover it for a depth of nine to fourteen inches." May I advise that this covering has now been increased so that there will be not less than 2½ ft. of covering when the fill is completed, and, furthermore, instead of the top covering being placed every second or third day, as was the former practice, it is now covered at the end of each day's shift.

We find that this type of land fill also wards off the possibility of fires. This can be testified to by the fact that we have had no fires on any of the locations where this new system of land fill has been used.

May I take this opportunity to extend my hearty congratulations on the splendid way in which the subject has been presented.

WILLIAM F. CAREY
Commissioner, Dept. of Sanitation
New York City

Sir: I have read the article in the Sept. 1 issue of *Engineering News-Record* glorifying the disreputable garbage dumping methods in the City of New York. Mr. Cleary goes into the most dubious and misleading statistics to bolster up his conclusions and completely overlooks the major aspects of the problem.

What about the seven incinerators that have been shut down by Commissioner Carey with a consequent increase in the amount of raw garbage dumped in the open? Mr. Cleary fails to say anything about this. What about the millions just spent by the City of New York to remove two great dumps in the Flushing Meadows and at Riker's Island to get rid of costly civic blunders in anticipation of the World's Fair? What about the tremendous depreciation in values and assessments the City is suffering due to the blight on surrounding properties caused by these garbage dumps? Mr. Cleary should have included those in his figures. As to Jamaica Bay, Mr. Cleary evades all reference to pollution of water, destruction of swimming, boating, fishing and wild life, making stinking dumps out of the pleasant islands and numerous other objectionable features of the Carey program.

The answer to New York City's garbage disposal problem is to separate garbage from ashes, bottles, cans and solid stuff, to incinerate the garbage in modern plants and to use clean ash for land filling. To repudiate this program and to embark on one of water dumping in a closely built-up city, such as ours, is stupid, barbaric, costly and so unpopular that neither my friend, Commissioner Carey, nor any other public official can survive it. Why a reputable technical magazine should endorse such tripe is beyond me.

ROBERT MOSES
Commissioner, Dept. of Parks
New York City

Opinions are one thing, facts are another. The Department of Parks, which is so ably managed by Mr. Moses, has provided at least four sites where land fills are now being made in order to prepare them for eventual development as recreational areas; see editorial note on p. 318.

—EDITOR

Sir: I am indeed glad to see that other cities besides Mobile are using the land fill method. During the depression this city was required to drastically decrease all operating expenses and, among other things, eliminated the operation of the two incinerators. When the incinerators were closed down garbage was hauled to a dump and sealed with street sweepings which are composed mostly of sandy soil interspersed with leaves. Seldom have we been compelled to resort to the use of chemicals to eliminate obnoxious odors; in fact, I think there has been less odor emanating from the garbage that was dumped and covered than came forth at times from the chimneys of the incinerators.

The operation of the incinerators

(Continued on adv. p. 21)

ENGINEERING NEWS-RECORD

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SEPTEMBER 15, 1938

A BETTER HOUSEBUILDING year than anyone thought possible a few months ago now seems probable. The principal basis for such hope rests in FHA figures on mortgage insurance acceptances, which increased 50 per cent in July and August over the average month in the first half of the year. Even if this trend should drop off it is likely that FHA totals for the year will equal $600,000,000. Building and loan mortgages totaled $330,000,000 in the first 6 months, and should exceed $600,000,000 for the year. If other building should reach the modest total of $200,000,000, we will thus have a 1½ billion dollar housing year. Discounting repair work in this total, it represents over 200,000 housing units of $5,000 each. Too many people have been selling housing prospects short. A look at the record may make them feel better.

Refuse Fills Found Useful

CURRENT INTEREST in the live subject of refuse disposal by land filling is heightened by the spicy letter of Robert Moses, New York's efficient and redoubtable park commissioner printed on another page. Everyone will agree with Commissioner Moses in his comments on "raw garbage dumped in the open", but these remarks need to be read in the light of present facts: that several park fills of mixed refuse have been made during Mr. Moses' direction of the park department, that four additional fills are now being made for the park department, and that within the past few weeks Mr. Moses has taken the initiative in asking that a new refuse-filling operation of great size be begun, to enlarge the area of a park now under construction. As he proposes to open one section of this park to public use while the filling is going on, he evidently does not apprehend any "blight". His letter as we print it does not adequately reflect this factual endorsement of the value and economy of well-managed refuse filling.

Treating Textile Wastes

DESIGNED to provide for the application of more than a dozen different combinations of treatment processes, the sewage disposal plant just completed at Greensboro, N. C., ranks as one of the most flexible ever built. Special circumstances dictated this need for flexibility and quick change-over, as outlined in an article on page 321. Since the sewage reaching the plant contains large quantities of textile wastes, the characteristics of which are subject to rapid variations, methods of treatment must likewise be varied to give highest purification at least cost. Basically, the plant provides chemical precipitation and activated sludge treatment, along with sludge elutriation, digestion and vacuum dewatering. Greatest interest lies in the layout of the various units and the manner in which they can be interconnected and operated. Because of the unusual features of flexibility and the opportunity to carry on large-scale experimental work, much practical knowledge of textile waste treatment can be developed. The findings may give considerable impetus to stream pollution abatement in the South and in other textile centers.

Innovation

THE GALVESTON CAUSEWAY described in this issue happens to be one of the country's longest viaducts and thereby provides an example of the extent to which road transport is compelling large investment in wide entrance roads to cities. To the technician it illustrates a new order of thinking in hurricane bridge design, and to the constructor it offers a comparatively new method of procedure in bridge erection over wide shallow waters. The construction of a navigation canal the full two-mile length of the Galveston viaduct has a counterpart only in the construction of the Neches River bridge near Port Arthur, Texas, by the same contractors. In both operations the novelty was not in the use of floating plant but in the use of many light shallow-draft floating units instead of a few heavy powerful units. The light units had greater mobility, required less costly canal excavation, were easily scattered to handle many repetitive operations and as easily grouped where the operation required the combined power of two or more.

Violations Encouraged

HIGHWAY DEPARTMENTS are in part responsible for some of the violations of rules of the road that are seen on every hand. This condition appears to rise from too close adherence to general regulations in marking highway lanes and setting highway signs. For example, current practice calls for painting a center strip around curves on two-lane or three-lane highways to indicate to drivers a zone in which passing the car ahead is dangerous. Such limit on passing is very desirable on obscure curves, but there are many places where a short curve with a clear view makes the limit unnecessary. Blindly following the rule that calls for a

line results in quite general violation of the rule on such curves. The same is true of stop signs. All over the country they can be found at points where only the Casper Milequetoasts stop, simply because it is evident even to careful drivers that no stop is called for. The effect of such situations is obvious. It weakens respect for signs and markings that should be respected. Our state highway departments should make periodic restudy of their roads to see where needless marking can be eliminated. Elimination of many signs and pavement markings that now foster habitual violation of rules should be a major step toward obtaining better respect for signs and more safe driving on our highways.

Theories and Realities

THE President has named a committee of cabinet officers and other high federal officials to study and report on power supply for the nation in case of a major emergency. He has been told by unknown advisers that the nation's margin of power generating facilities is much too limited. In the same week the Niagara-Hudson Power Corp. announced that it will build a large steam-driven power station at Oswego to supplement its wide network of stations across northern New York. The two announcements provide food for thought.

It is safe to assume that the new power committee will find that there would be a power shortage should our industrial load be raised suddenly by a war emergency. That fact is well known. It may also be assumed that the same committee will find that the potential shortage gives special value to the power development projects that have been financed with federal funds; also that the shortage serves as an indicator that private initiative has been falling down on its job, making it necessary for the federal government to expand its activities along that line. The great generators for Grand Coulee doubtless will be cited as being available to meet the demand. Nothing will be said about the slowing up on private initiative in power development due to uncertainty as to what the federal government is going to do next.

But even a casual inspection of a power demand map of the country will show that the many power projects financed by the federal government were not located with that map in mind. Political expediency largely controlled their location.

In sharp contrast is the Oswego power plant. It is placed where it will be most useful in meeting the anticipated growth of demand from an expanding system serving one of the great industrial areas of the country. There would be many more like it ready to meet either growing industrial demand or national emergency were the federal government to stop letting impractical theorists fix national power policies. If Congress wants to experiment with public power development let it lay down a definite policy limiting the experiments to clearly defined areas.

The need for a large amount of power plant construction exists. No cabinet committee is required to tell us that. What is needed is fewer theories and more recognition of realities in Washington. The many plants that would be built were national power policies stabilized would go a long way toward improving general business conditions.

Engineers as Planners

ENGINEERS were conspicuous by their absence from the International Housing and Town Planning Congress recently held in Mexico City. Few of those who were present took any active part in the deliberations. Unfavorable business conditions may have been largely responsible for this apparent lack of interest on the part of engineers, but it may be due to the fact that those who plan such congresses feel that engineers lack the attributes essential to city planning.

One engineer who attended put forward the latter explanation. He said that sociologists and other persons interested in planning believe that a new social order is in the making which calls for a new profession of city planning in which knowledge of engineering is not essential. Such a view is unfortunate. Engineers may lack some of the broad understanding of social problems possessed by the trained sociologist, but their natural capacity to recognize and provide for realities should more than offset that lack, especially when they are working in cooperation with sociologists in planning work.

Vision is needed in planning, but too much of our city planning has been so overloaded with visionary ideas as to be wholly impractical. A balance between vision and actuality is needed, and engineers are best fitted to supply the balance.

If a new social order is developing, if industry is to be decentralized, thus causing a shift away from the centers of population and major changes in our housing and transport needs and in our public services, engineers can be of great help in laying down plans that will minimize the losses that are inherent in any such change. Planners unhampered by engineering background may be able to lay down a plan for a new community or for a rebuilt community that is ideal for social needs, but unless such plans can be modified to meet physical limitations they can hardly succeed. Here is an opportunity for community service that engineers should not lose through indifference or failure to study its possibilities.

PICTURES IN THE NEWS

Photo by Edgar Lee Girder

CONSTRUCTION *progress on Conchas Dam. For the benefit of camera fans, this unusual photograph of the upstream face of the dam was achieved in broad daylight by use of an infra-red-sensitive plate and a dark red filter, which exclude blue and ultra-violet light.*

ROUGH TOPOGRAPHY *is characteristic of this new road recently built by the California Division of Highways into the Kings River canyon as part of a new route to General Grant National Park. In the canyon it was necessary to resort to tunneling and to such expedients as carrying the outer half of the road on an arch and niching the remainder into the cliff.*

Tackling Textile Wastes

Greensboro, N. C., completes a chemical precipitation-activated sludge plant of unusual flexibility to treat domestic and textile wastes

IF THERE IS any method, combination of processes, or operating procedure by which sewage containing 25 per cent of textile waste can be handled economically at a municipal disposal plant, Greensboro, N. C., is now in a position to find out. A new plant, incorporating features representing the most advanced thinking in equipment, layout and treatment practice, plus unusual facilities for flexibility in operation, has just been completed. More than a dozen different combinations of treatment can be applied, the changeover for which can be easily made by merely opening and closing valves and control gates.

Combines processes

Essentially, the plant is a combination chemical precipitation and activated-sludge installation. In addition, it includes separate sludge digestion, and facilities for the elutriation of sludge prior to dewatering it on vacuum drum filters. Power to operate the plant will be produced from digester gas.

Like most of the textile centers in the Southeast, where abatement of stream pollution is a major problem, Greensboro has been faced with the necessity of not only treating its domestic sewage but of also making provision for the treatment of industrial waste. In volume alone, the latter amounts to about 2 m.g.d., representing 25 per cent of the total sewage flow. Considered on the basis of population equivalent, the industrial waste pollution is equal to that from 20,000 people. This pollution, plus domestic wastes from a contributory population of 40,000 created conditions in the small receiving stream which caused a deficiency of more than 8,000 lb. of oxygen per day. Of the 10,000 lb. of oxygen required for the stabilization of the municipality's waste, the stream could furnish only about 20 per cent.

A course of action

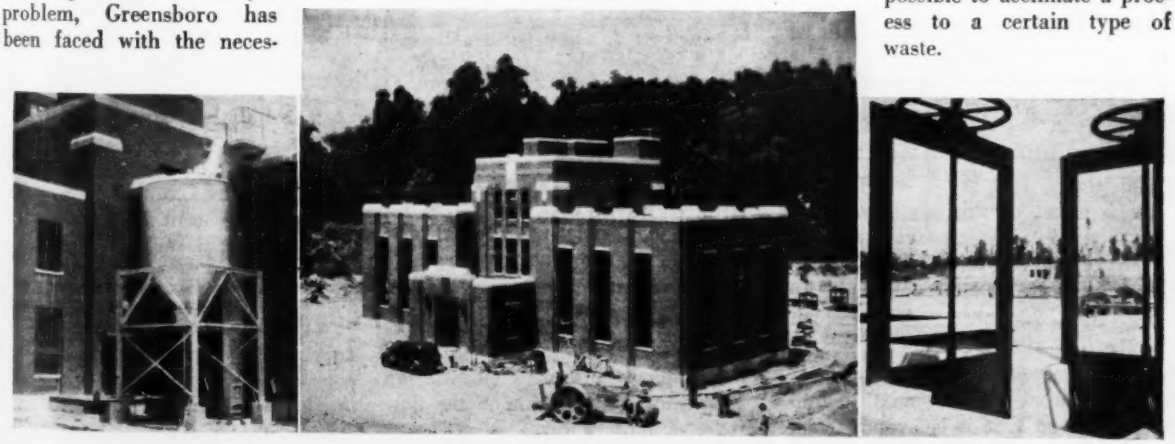
Treatment of domestic sewage alone would not solve the problem of stream pollution abatement—something had to be done with the industrial waste as well. The only possible courses of action were to require pre-treatment at the mills before the waste reached the city sewer, or to build a municipal plant that would take care of the raw waste from both domestic and industrial sources.

For several reasons the latter course seemed most desirable. To require the installation of individual treatment plants would have put mill owners, already overburdened with difficulties, to heavy expense. Furthermore, to coordinate the operations and discharges of these plants would have been a complicated and generally unsatisfactory business for all concerned.

Special problem

It was fully appreciated, however, that a municipal plant for treating domestic sewage is not necessarily adapted to handling sewage containing textile wastes. Sewage treatment processes depend largely on the cultivation and functioning of biological life.

Textile wastes, because of their irregular discharge, rapid changes in character, and toxic nature may completely upset these biological activities. Thanks to the adaptability of biological organisms to their environment, however, it is sometimes possible to acclimate a process to a certain type of waste.



ENR Photos

Fig. 1. **Control Building at Greensboro (center); the hopper tank for storing dewatered sludge (left); digestion tanks framed by sluice gates in a bypass channel (right).**

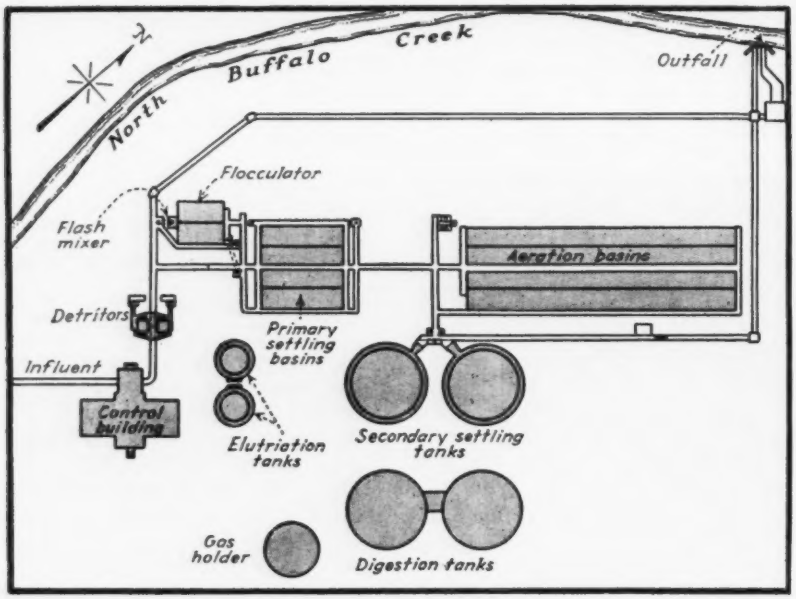


Fig. 2. Unusual flexibility of operation is provided by means of bypass channels which permit the use of more than a dozen different combinations of treatment at the Greensboro plant.

DESIGN AND ENGINEERING DATA

Treatment: Comminutors (with auxiliary bar screen), grit removal and washing, chemical precipitation, primary clarification, activated sludge, final clarification, chlorination, sludge digestion, elutriation, vacuum drying, gas recovery and utilization.

Plant Capacity: 6.5 m.g.d Population served 40,000 plus 20,000 equivalent in textile wastes.

Comminutors: 2 units, each with a capacity of 6.5 m.g.d.

Grit Removers: 2 tanks each equipped with a detritor and organic return mechanism; capacity 13 m.g.d.

Chemical Mixing Tanks: 2 tanks, each 45x19 ft.; equipped with paddle wheel flocculators.

Primary Clarifiers: 4 units, each 80x20 x14 ft., equipped with longitudinal sludge scrapers.

Aeration Tanks: 4 units, each 260x 17x14 ft.; porous plate air diffusers for spiral flow; 6 hr. detention.

Final Clarifiers: 2 units, each 75 ft. dia., 9 to 13 ft. in depth; circular sludge scrapers.

Digesters: 2 units each 75 ft. dia., 10 to 12 ft. depth, floating covers, capacity 2 cu.ft. per capita.

Elutriation Tanks: 2 units, ea. 28 ft. dia., 14 ft. deep; equipped with stirrers and sludge scrapers.

Gas Holder: steel tank 47 ft. in dia.; capacity 30,000 cu.ft.

Chemical Feeders: 2 manual chlorinators; 4 dry feeders; 2 transport dissolvers.

Vacuum Filters: 2 drum type units, 8 ft. dia. and 10 ft. in length.

Power Equipment: 2—150 hp. gas engines directly connected with 100 kw. generator.

Air Blowers: 3 rotary positive type units, capacity 1,750 cu.ft. of air per min. at 6-7 lb. gage pressure, at 100 deg. F. inlet air temperature.

The secret of this acclimatization is to maintain constancy of the character of the waste. This can be accomplished in large measure by providing equalizing tanks in which the various kinds of waste are mixed, and then regulating the discharge of this somewhat uniform mixture into the sewer so that it is proportioned to the flow.

At Greensboro, fortunately, the textile wastes are all brought to a series of lagoons previous to their discharge into the sewer. Thus an opportunity for equalization is afforded and in addition, the discharge from the lagoons may be controlled to maintain a uniform concentration of the wastes in relation to the flow in the sanitary sewer.

This situation removed one of the hurdles in connection with treating the combined waste. The next hurdle was to design a plant incorporating processes which would most effectively and economically handle the mixture. For this no precedent existed. As so clearly evidenced and stated in the authoritative survey and report of The Textile Foundation, Inc., made in 1936, every textile waste treatment problem involving combination with domestic sewage, is a problem requiring independent solution. The factors involved depend entirely on local conditions.

Accordingly, the Greensboro plant was designed to provide utmost flexibility both in operating methods and adaptation to various methods of treatment. To accomplish this purpose the various units of the plant have been interconnected with an elaborate system of channels and piping. By this means it is possible to operate individual basins of a unit either in series or parallel, as well as to connect or bypass units in any combination desired.

Further flexibility in operation is provided by chemical handling and feeding equipment. This is so laid out that from the control building, which houses the chlorinators, dry feeders and transport dissolvers, it is possible to apply chemicals at the following points:

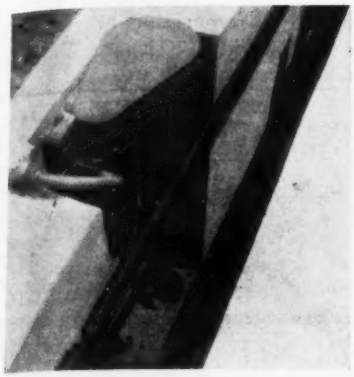
1. Chlorine at the influent to the plant
2. Lime after the sewage has passed through the comminutor
3. Iron, chlorine, alum, carbon, etc., at the entrance to the flash mixer
4. The same chemicals as above at the entrance to the aeration tanks or to the final settling tanks
5. Chlorination at the effluent discharge

What the plant includes

The plant has been designed for a capacity of 6.5 m.g.d., which is some 40 per cent greater than the present flow. Because of the experimental nature of the plant, as well as to take care of consistent population growth, it was deemed desirable to provide generous over-capacity at this time.

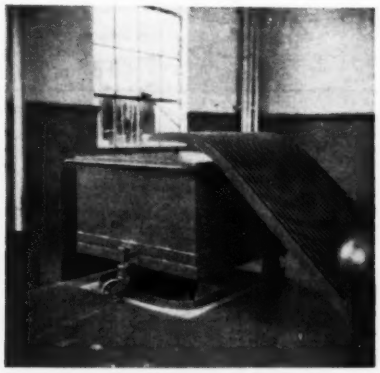
The treatment devices (details of which are given in a table on this page) include two comminutors and a 1-in. emergency bar screen in

LOOKING AROUND THE PLANT

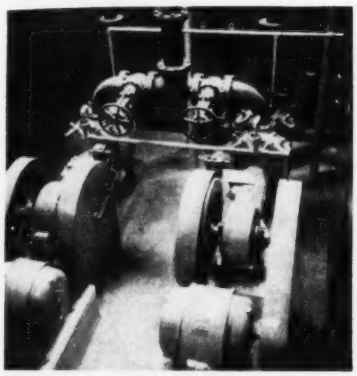


DETRITOR PUMP

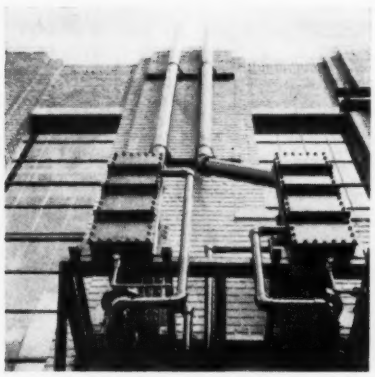
COMMINUTORS



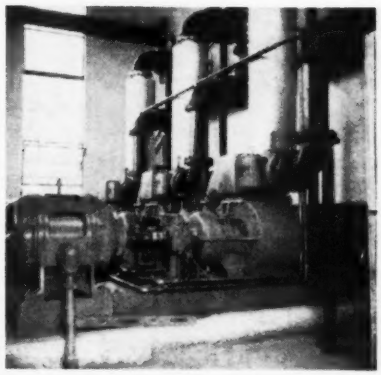
SCREENINGS CAR



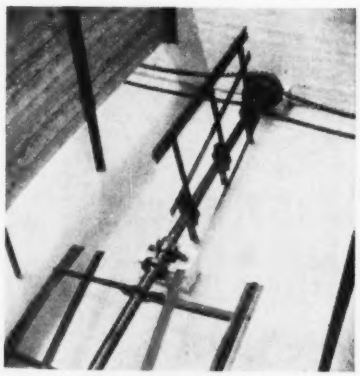
FILTER VACUUM PUMPS



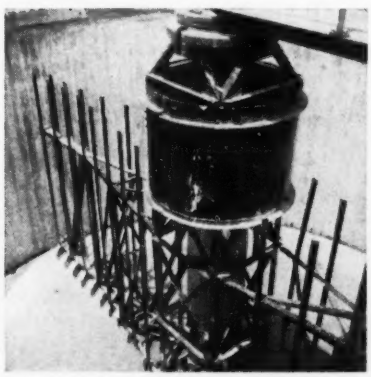
WASTE HEAT BOILERS



ROTARY AIR BLOWERS



FLOCCULATORS



ELUTRIATION TANK

AERATION TANK

the control house, followed by two detritors. The grit removing mechanism on the latter is of an improved type in that it is provided with a small propeller pump that returns organic solids to the detritor basin where they are carried out with the sewage.

The flash mixer is of the impeller pump type, and it is followed by two baffled basins in which there are installed paddlewheel flocculators. The rectangular primary settling tanks are equipped with longitudinal scrapers; one of the interesting features on these tanks is a scum weir and sump located on top of the underflow effluent weir. Scum can be drawn into this sump and pumped directly into the digestion tank. The final settling tanks are circular and have rotating sludge removers. Aeration basins are equipped with porous plate diffusers which are held in place with aluminum holders that permit quick and easy removal of the plate for inspection and cleaning.

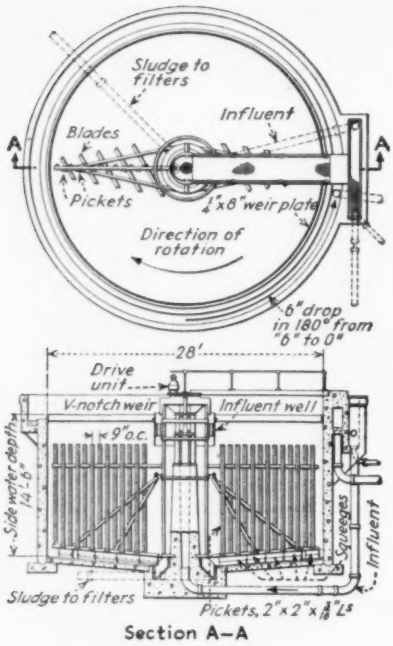


Fig. 3. Elutriation tank details.

Primary and excess activated sludge will be digested in two tanks, each with a capacity of 130,000 cu.ft., which can be operated either as single units or for multiple stage digestion.

The digested sludge will be elutriated (namely, "washed" with plant effluent to remove chemical-absorbing compounds) prior to chemical conditioning and dewatering on vacuum filters.

For this purpose there are two concrete elutriation tanks 28 ft. in diameter and 14 ft. deep. They are equipped with a stirring mechanism of the "picket-fence" type, on the bottom of which are scrapers which move the settled sludge toward a central sump. The digested sludge mixed with a certain proportion of washwater (plant effluent) enters the tank through a hollow column in the center and diffuses outward at the tank surface. The supernatant liquid is drawn from the tank over a circumferential weir, and the "washed" sludge settles while being slowly stirred. The tanks are connected so that they can be operated in parallel, or for double washing, they can be operated in series.

Power and heat

Digester gas, which will be stored in a 30,000-cu.ft. holder, will be used for both heating and for power production. For the latter purpose, two 150-hp. engines, each connected to 100-kw. generators, will be employed.

In order to obtain hot water for the digesters, four alternate methods have been provided. For standby and emergency service there is a coal-fired boiler. When the gas engines are running, hot water may be obtained either from waste heat boilers connected to the engine exhaust, or from the engine jacket water. Should these be insufficient to supply all the hot water needed, there are available two gas-fired boilers.

Automatic hot-water control is provided by means of special three-way valves which can be set to maintain a predetermined temperature. For instance, if the valve is set to pass water into the digestion tank coils at 100 deg. F. and the temperature of the incoming water exceeds this figure, the valve will open to permit the introduction of cool water returning from the digester. This mixing is an entirely automatic operation.

Operating procedure

As was stated earlier, no definite method of operation has been decided upon. At the time of this writing, the plant is treating nothing but domestic sewage in order that the biological processes, such as activated-sludge and sludge digestion, can be established in working order.

The wastes from the textile mills, which is stored in lagoons prior to discharge into the stream, will be diverted to the sewer system as soon as the plant is in working order. A proportional flow device has been installed at the lagoon and when this goes into operation it will proportion the discharge of waste to the flow of domestic sewage in the sewer. Thus it will be possible to minimize fluctuations in the composition and proportions of the mixture.

Who did it

Behind the conception and completion of the Greensboro plant lies the cooperative activity of many individuals and several agencies. Among these are C. W. Smedberg, city manager; C. W. Mengel, director public works; W. M. Lybrook, superintendent of water and sewers; William C. Olsen of Raleigh, consulting engineer who designed the plant; and C. H. McQueen, who served as PWA resident engineer. Now in charge of plant operation is E. H. Moss, formerly operator of the High Point, N. C. plant. Prior to the design of the plant, stream surveys were made by the sanitary engineering division of the North Carolina state department of health.

Funds for the job, which cost $705,000, were obtained from a city bond issue and a 45 per cent grant from PWA. The Cone Mfg. Co., textile producers, contributed a portion of the cost of the chemical equipment installed primarily for the purpose of treating their wastes.

The general contractor on the work was V. B. Higgins Co., of Greensboro, for whom R. J. Patterson was superintendent of construction.

• • •

Louisville Meter Practice

BENEFITS due to overhauling, testing and repairing water meters at Louisville, Ky., are indicated by the increase in the percentage of total water pumped that is registered by meters in service. That regaining lost accuracy of registration in the meters is equivalent to regaining lost revenue is pointed out in the annual report of L. S. Vance, chief engineer and superintendent of the water department. Of the 5,743 small meters that went through the shop during the last eight months of 1937, almost 6 per cent registered less than 90 per cent of a flow of one gallon per minute. Of that total, 11.8 per cent registered only 90 to 98 per cent, and less than 77 per cent registered within the required limits of accuracy.

In exchanging meters, it is the policy to reduce the size to more nearly fit actual water rate demands, and also to install a controlled battery of meters in place of a single large meter. This latter practice results in greater accuracy of registration, lower maintenance cost for the two or three smaller meters, maintenance of meters without complete interruption of service to the consumer, and lower original installation cost.

Structural Welding Advances Under New York City Code

In eight months since the code became effective approved welding construction has totaled nearly 3,000 tons

SINCE THE FIRST OF THE YEAR, when structural welding achieved recognition in New York City by the adoption of the new building code, between 2,500 and 3,000 tons of building steel have been welded. All of the structures involved were designed initially for riveting and later were converted or redesigned for arc welding.

Some 60-ft. plate girders

Work began with some 60-ft. span plate girders in three large public schools. After receiving the contract on a riveted basis, the contractor requested and was granted permission to redesign the plate girders for shop fabrication by welding. Taking the three schools together, there were 36 welded girders which accounted for about 250 tons of welded steel on the basis of an average weight of about 7 tons each. The original riveted designs, it is said, required a weight of 10 tons for each girder, so that a metal saving of 33 per cent was effected by the change to welding.

Next followed the first all-welded building to be built under the code, a 14-story apartment at 7th Ave. and 20th St., known as Kensington House. This relatively large job, involving 720 tons of steel, had been designed for riveting, and the changeover to welding was made simply by redesigning the connections; beam and column sizes were not altered.

Using the welded girders in the schools as a precedent, permission was next received to redesign three identical grade schools, one in Queens and two in the Bronx, for both shop and field welding. Each of these schools required 430 tons of steel.

All of the above work, including the apartment house and the school buildings, was done by the Lehigh Structural Steel Co. These jobs are now completed, but erection is under way on a 7-story all-welded building for the New York Telephone Co. This building will require about 430 tons of steel, and steel fabrication and erection are in the hands of the Ingalls Iron Works Co.

In addition to the above buildings, a number of small structures and alteration jobs have included some structural welding, notable examples being the reinforcing of the first story columns in the office building at 32 Broadway, and industrial plant alterations for the Pepsi-Cola Co. in Long Island City.

Other current welded work, not subject to the New York building code but located within the city, includes four of the buildings for the New York World's Fair and the addition of four stories (about 330 tons of steel) to the New York State Hospital in Brooklyn. Designs are also under way on the Triborough Hospital for Jamaica, Queens, for which alternate bids on welding versus riv-

Fig. 1. **First all-welded building erected under the new building code in New York is this 14-story apartment house.**

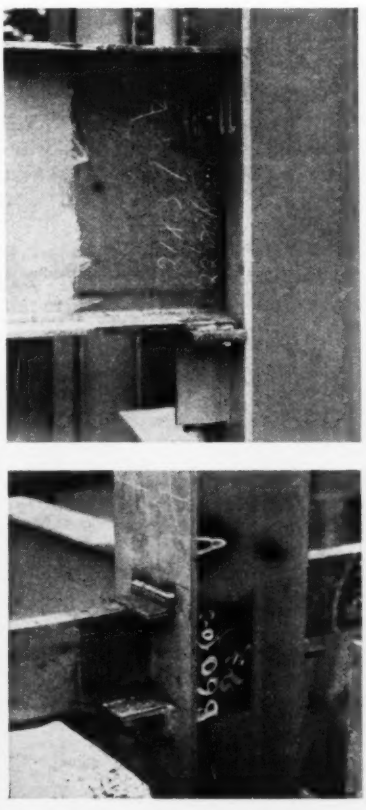


Fig. 2. **Typical beam-to-column connections. Above, a split-I seat in a school building. Below, a seat-angle connection.**

All photos from Air Reduction Sales Co.

Fig. 3. **Welder making a column splice during the erection of the framework of the 14-story apartment building.**

eting construction will be received.

None of the buildings so far welded involves any innovations so far as welding technique or joint designs are concerned. Compared with the conditions existing several years ago, however, it is notable that only about half as much field welding is now done as then. Shifting as much of the welding work to the shop as possible has been found to be an economy measure under the existing relative labor costs in shop and field.

Joints are laid out so that in the field there is no overhead welding and, as between vertical and horizontal field welding, the ratio is about 2 to 1. Nearly all field welds on buildings so far built have been of $\frac{1}{4}$, $\frac{5}{16}$ and $\frac{3}{8}$ in. size. Framing of beams to columns has been accomplished wherever possible by seat connections, which can be welded to the columns in the shop. Architectural considerations permitting, large-capacity connections are made with split I-beams for seats; otherwise, angles are used, supplemented by web connections, if necessary. Top flanges of beams are connected to columns by angles; the upstanding legs of such angles are made shorter than the horizontal legs to increase the rigidity of the connection without actually making it fixed. All column splices are made through intervening flat plates welded to the top of the lower tier column in the shop.

The welding design on all of the structures noted has been done by Gilbert D. Fish, consulting engineer, New York.

Licensing Welders in New York City

Civil Service Commission gives first qualification tests to 30 applicants of whom 21 pass

PRACTICALLY all of the structural welding work of the past eight or nine years has been done by qualified welding operators, the qualifying tests being conducted at the instance of the insurance companies or the engineers and contractors on each particular job. In the new building code for New York City, however, welder qualification is shifted to a license basis, and rules and procedures are given for the city authorities to carry out the necessary tests and to issue the licenses.

In line with the requirement that all welding operators working on structures subject to the code shall be licensed, tests were held for thirty applicants on July 27 and 28. Twenty-one of the men passed the qualification tests, which are those recommended by the American Welding Society for arc welding in vertical, horizontal and overhead positions. The specimens consist of two steel bars $2\frac{1}{2}$x$\frac{3}{4}$x9 in. long joined by two cover plate bars $2\frac{1}{2}$x$\frac{3}{4}$x$\frac{1}{2}$ in. long attached by $\frac{3}{8}$x$2\frac{1}{2}$ in. transverse fillet welds at the ends. These specimens when pulled in tension are required to develop an ultimate strength of 30,000 lb. if welded with covered electrodes. The tests for two specimens cost $5 for each position, and most of the men elected all three positions. Following qualification, the men are issued licenses at $2, good for one year.

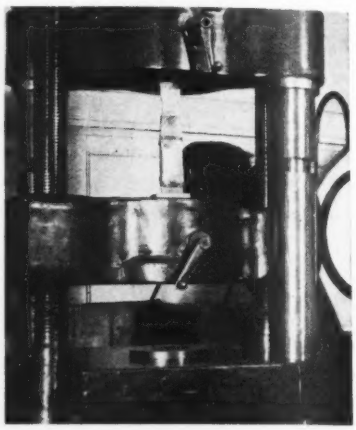


Fig. 2. Weld specimen after being broken in testing machine in city laboratory.

Fig. 1. Four applicants seeking New York City licenses make their weld test specimens under the eyes of two Civil Service Commission inspectors.

Inspection of building work in New York City is under the Department of Housing and Buildings and, according to the code, the commissioner of this department is empowered to appoint a board of examiners for welders from the personnel of his department, or he may accept the results of qualification tests conducted by a private testing laboratory. As a matter of fact, a combination of these two procedures was used to qualify 7 welders early in the year who were required for work on the first few welded buildings. Subsequent investigation led the city to conclude that it could conduct the tests at less cost, and, as a result, the Civil Service Commission, which already has the responsibility for testing and examining the city person-

nel, was chosen to act as the board of examiners for welders. The city testing laboratory is available for pulling the specimens, and on the recent tests the Lincoln Electric Co. furnished welding equipment and rod.

Inasmuch as the qualification tests are not considered to constitute proof that a man who can pass them is a good welder, the Civil Service Commission has required that applicants must have had at least 1½ years welding experience on work subject to the codes of the American Society of Mechanical Engineers, of the U. S. Department of Commerce or of the American Welding Society.

The men recently issued licenses may work on any building built by welding in New York City and are also eligible for shopwork in fabrication intended for use in New York City. The Civil Service Commission, it is understood, will require that welding operators in fabricating shops, whether in New York City or not, must hold New York City licenses to work on material intended for erection in New York City.

New Hurricane Bridge Design

The new 8,200-ft. highway viaduct across Galveston Bay is a striking example of changed thinking in the design of bridging to resist hurricane wave action

GALVESTON, TEXAS, from its island location, must bridge almost two miles of open water in Galveston Bay to get highway travel to the mainland. Over the years its task has suffered many setbacks. First, the sea and hurricanes have twice brought complete or part destruction of the birdge work, (which Galveston has always called causeways) and then when a structure sturdy against the elements was attained highway motor traffic surged upon it and in a decade rendered it obsolete. Now a new and larger bridge is nearing completion to supplement the old one, but it is wholly unlike the old one, representing another theory of design to meet storm-tide conditions.

When the old structure was built the thought was to resist waves and wind by the strength of mass. In the fall of 1900, Galveston had been partly destroyed and all of its bridges (timber trestles) to the mainland swept away by tropical hurricanes. To guard against the repetition of such a disaster it was planned to raise the city grade behind a massive seawall along the ocean front and to provide a hurricane-proof causeway across the bay to the mainland. The seawall was built first and it was not until 1911–12 that the permanent causeway was constructed. As first built it consisted of a central part of 2,245 ft. of 70-ft. span solid-spandrel concrete arches and of approaches at each end built of earthfill between lines of concrete sheetpiling 139 ft. apart. Mass strength of structure was called upon to resist hurricane seas.

The test was not long delayed; in August, 1915 a hurricane came and the causeway was battered and swept by a storm tide 12 to 13 ft. high. The arch structure stood, although there was somewhat alarming scouring around the piers, and, curiously, the sheetpiling stood although

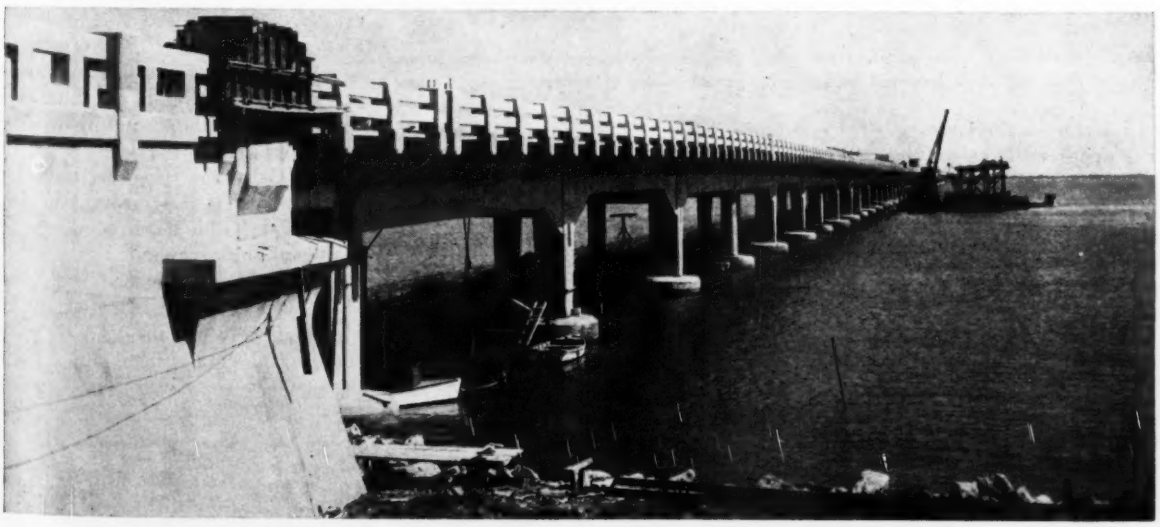


Fig. 1. Galveston's new 8,200-ft. "causeway" is a modern continuous girder viaduct

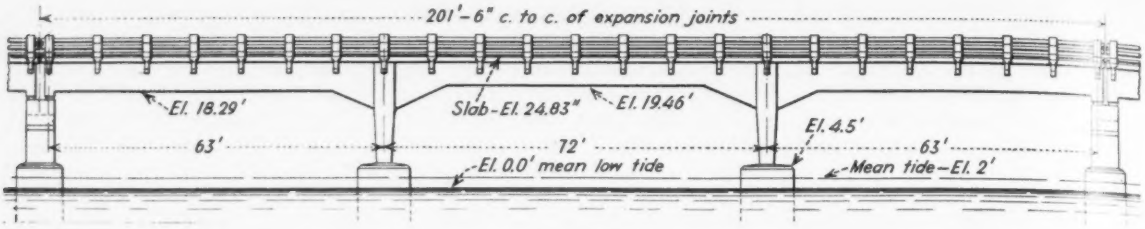


Fig. 2. Continuous girder units of three spans, 39 such units making up the greater part of the viaduct length.

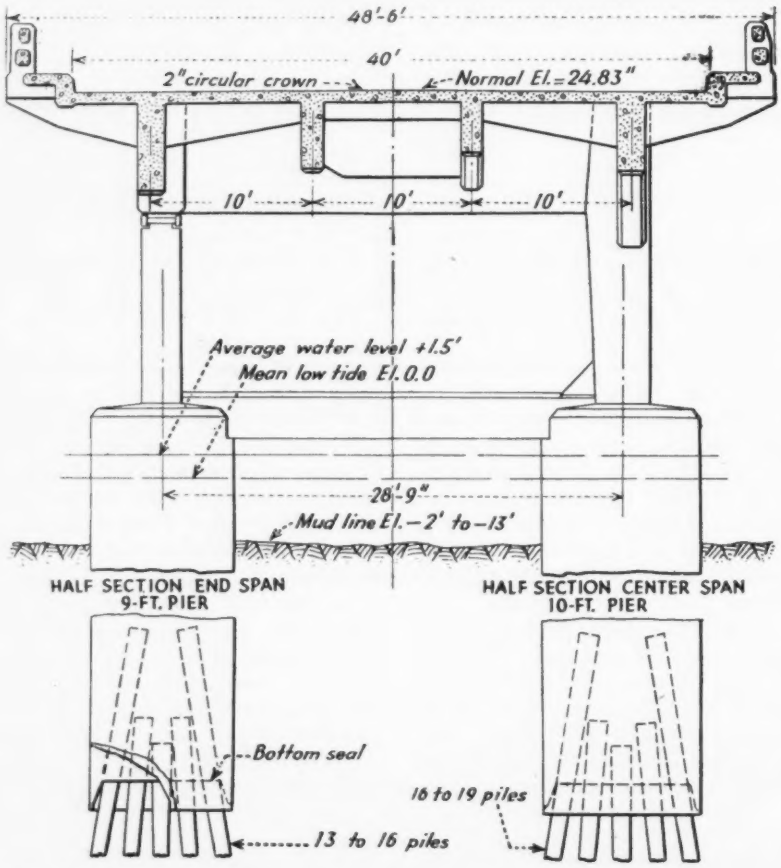


Fig. 3. A stiff box frame at piers gives lateral resistance against storm-wave surge, and impact is lessened in force by greater wave clearance.

the interior earthfill was washed out to a depth even below the original bottom. A board of engineers called to advise on reconstruction recommended replacing the fill with 5,530 ft. of concrete arch viaduct like the part already built. This was completed in 1922.

When in 1935 the pressure of road traffic and the possibility of PWA financing pointed to an additional bridge it was considered preferable to meet wave attack by giving passage to the waves instead of resisting them by massiveness of structure, hence the design indicated by Figs. 1, 2 and 3 was adopted. As shown in the drawings, the structure is quite open and high, the roadway being 25 ft. above mean low tide; this is 8 ft. higher than the roadway of the old causeway.

Elements of new design

But beside the main change from the massiveness of solid arches to open structural frame, the new bridge represents modernization in the design of girder viaduct. With the exception of the draw and its flanking spans occupying 276 ft. and a 33-ft. girder span at each shore end, the viaduct consists of continuous girders in three-span units (Fig. 2) carried by columns rising from twin cylinder piers. Altogether there are 39 continuous-girder units each 201 ft., making, with the navigation and abutment spans, a total of 8,200 ft. of bridging. To this bridging one 700-ft. and one 4,200-ft. approach embankment add 4,900 ft. of length; the bay parts of the fills are held by toe walls of sheetpiling.

With the open structure to reduce lateral impact of storm waves, there is provided sound structural resistance as shown by the drawings in Figs. 2 and 3.

The cylinders penetrate some 8 ft. of clay, and the batter of the piles gives them a large bearing circle in the clay below the cylinders. Above the pier tops, the cross-struts between column bases, and sturdy columns and heavy deck structure provide a strong box frame to resist lateral forces. All concrete is heavily reinforced. Longitudinally the main dependence for stiffness is the coupling together of the intermediate piers of each three-span unit by a heavier column section, the haunching of the girders and a deck structure rigidly connected by monolithic concreting.

Design generally has taken into account all the complex forces of cyclonic storm wave action, and provision made to resist them. The technical details are for discussion in another place. Here only the difference in present thinking and that of a generation ago is indicated.

The Causeway was designed by Terrell Bartlett, Engineers, San Antonio, Tex. Gibb Gilchrist was state highway engineer and Herbert Eldridge, bridge engineer. This is a PWA project and at that time Julian Montgomery was state PWA director for Texas. Since then Mr. Montgomery has succeeded Mr. Gilchrist as state highway engineer. T. J. Kelly of the highway department has been supervising engineer of construction. The field work has been one of the most interesting elements of the project and it is described in the following article.

Viaduct Built From Barges

Over two miles of viaduct and earth causeway constructed at Galveston by dredging a parallel canal for light, fast-moving bargeplant

IN BUILDING the new Galveston causeway the problem was to plan construction methods and equipment to perform many repetitive operations over a long distance. The preceding article has indicated the elements of the new structure: Cylinder caissons for piers; pier columns carrying the girders, and three-span continuous girder units including the supported roadway deck. None of these elements was complex as concrete girder viaduct construction goes but there were many of each and they were distributed over a bridge length of 8,200 ft. and an additional footage of embankment approach that brought the length of work in water to nearly 2 mi.

A count of the structures

Galveston Bay at this crossing has a depth at average water level from 6 in. near shore to 13 ft. in the navigable channel; at low tide, which is a drop of 1½ ft., the water lines recede about 1,000 ft. from the normal shore lines so generally shallow is the water. The bottom of the bay is firm to soft alluvium for a depth of 2 or 3 ft., under this are irregular depths of soft clay, sand and alluvium and finally a deeper bed of firm clay. For about three quarters of the crossing the top of the firm clay varies from El —8 to El —15 (low tide being El 0), and for the remaining 2,000 ft. approaching the mainland it ranges from El —40 to El —15.

A count of the construction units includes: *Substructure*, 2 hollow bascule-span abutments, 36x60 ft. each, on 250 piles 40 to 60 ft. long; two shore abutments each on 500 piles 30 to 50 ft. long, and 219 piers of twin 9 and 10-ft. cylinders each on 16 to 19 piles 50 to 70 ft. long; *superstructure*, 1 plain girder span at each abutment and 39 continuous-girder units 201½ ft. long divided into three spans each; *approaches*, a 700 and a 4,200-ft. hydraulic fill retained in the water section by toe sheeting. These items make up 2 mi. of structures in water.

The problem before the contractor was to plan a plant to carry on several scores of like operations distributed over a length of 2 mi. and then develop a method (1) of sinking 238 circular concrete caissons in pairs and (2) constructing on the 119 pairs of cylinders 39 continuous girder units (117 spans) of superstruture (238 pier columns, 234 girders and 117 spans of deck). Abutment and approach construction of course entered into the problem but the cylinder sinking and superstructure concreting were the major factors to be worked out. How this was done is perhaps most interestingly told by drawing on a first-hand description given by Joe E. Grace, general superintendent, Austin Bridge Co., the contractor, at a recent meeting of the Texas Section of the American Society of Civil Engineers.

The construction plant for the causeway presented three possible choices: One, an all-land plant, an-

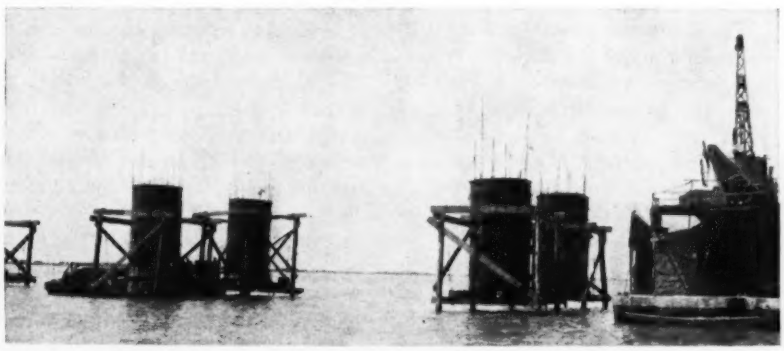


Fig. 1. Twin caissons for the piers were started on pile staging, lowered to the bottom by hand crabs, built up as they were sunk by dredging inside, bearing piles driven inside, sealed, pumped dry and filled and capped with concrete.

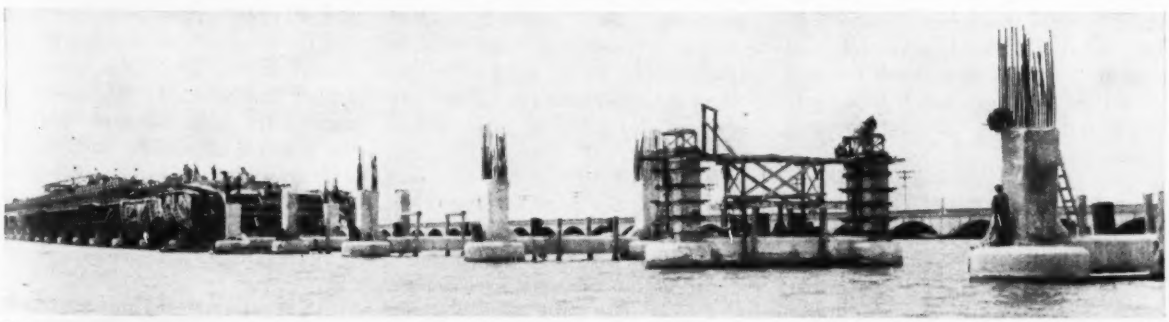


Fig. 2. Following caisson sinking column forms were erected and the columns were concreted ready for the girder and deck construction. Note the old 1912 concrete arch causeway in the background of this view

other a land-and-water plant and a third, an all-water plant. The all-water plant was finally decided on, although this meant, because of the shallow water, digging a flotation canal the full length of the viaduct structure and extended the length of the approach fills in the bay. This canal was extended on the west (mainland) end to two supply trestles from the shore yards, one carrying a standard gage track for materials in general and the other a 36-in. gage track for concrete materials.

It was decided to operate from the mainland end, first, because the high ground (El +10) offered protection and second, side tracks could be built into this location easily. The main siding is about 2,000 ft. long and extends into the bay 300 ft. on a trestle. Coming off of this track is another which serves the batching plant and is long enough to handle about 15 cars of sand, cement and gravel. Paralleling the concrete batching track is a 36-in. gage track which extends from the proportioning bins into the bay on a trestle and over the flotation canal. Near the end of this track and over the service canal is a 60-ft. truss span.

The 60-ft. truss enables barges to be spotted under the track for receiving dry-concrete batches; a 5-ton locomotive handles five cars, each of which carries two 1-yd. batches of sand and gravel. These cars have radial doors at the bottom for dumping through down spouts into rectangular shaped cans on the barges. Each can receives a 1-yd. batch. A sixth car in the train carries 10 separate batches of cement. These cement containers are conical in shape and the cement is dumped through a bottom door into separate compartments built in the 1-yd. batch cans. By this arrangement the cement is not mixed with the other materials until all three go into the mixer. Four batch barges carry 25 1-yd. cans each and enough water in each hold for the 25 batches. This plant will, if pushed, batch out 40 yd. of concrete per hour.

The mixing plant consists of one 1-yd. mixer on the end of a 30x50 ft. barge; on the other end is a 1-yd. crane. On all small pours, some of which are as small as 10 yd., this crane feeds the mixer and also hoists the wet concrete in 1-yd. bottom dump buckets. On large pours, where the mixed concrete can be troughed into position, the crane devotes its entire time to feeding the mixer; on all large pours, where the concrete has to be hoisted, a second crane barge is pulled alongside for hoisting the wet concrete into place. About 50 pours on the causeway ran 600 yd. each.

Although the advantages of this type of plant were seriously questioned it is thought by Mr. Grace that because of the many small pours, and the many moves required to place them, it worked out to the best interest of the contractor. All the units were light. The first cost of a heavy plant would have been two or three times greater, the canal would have had to be 3 ft. deeper and there would have been a tremendous amount of heavy towing required for each small pour. In case of a breakdown of any piece of equipment during one of the large pours it could be replaced with another; once one of the large pours was started it was reasonably certain that it could be made continuous to its end.

Caissons built on staging

In all 238 concrete caissons had to be made and sunk. Four piles were driven around each caisson and braced and capped. From the caps a platform was suspended by cables a foot or two above the normal tide and on these platforms the caissons were cast. Metal forms were used both inside and out but a corrugated metal form was used on the inside to develop enough shear to make the caisson and the caisson filling act together. After the first pour of each caisson was made and cured the cylinder was picked up by four large A-frame hand crabs; each crab handled the fall line of a set of triple blocks. With this rigging the caissons were picked up and lowered into place. Each was then sunk to such a depth as to make it stable leaving enough above the normal bay elevation for adding the second section.

The sinking of the caissons was carried on in the usual fashion. They were dredged from the inside and were loaded with 5 cast iron rings the size of the caissons, each weighing 7 tons. The most unusual thing about the sinking was the lack of trouble encountered and the closeness to which they were sunk to their final position. If the caisson landed on impervious material it was pumped out and the bottom leveled off by hand before the piles were driven; if it could not be pumped out, because of the water-bearing material that it stopped in, an airlift was used to scour it down to the proper depth. To prevent a run in from the bottom during this cleaning out process, a siphon was dropped over the edge of the caisson connecting the water in the bay with the water in the caisson. In this manner a constant head and pressure for air lift operation was maintained.

The pile driving in the caissons was carried on in the same manner whether the hole was dry or wet. A hammer with a long steel follow stick was used; the follow stick had guides on it for two thirds of its length so as to be held to the leads in the same manner that the hammer was held. Both hammer and follower operated in telescopic leads. As the pile was driven down the telescope leads went down with the hammer only to such a depth that it would not touch the caisson. These leads were then "dogged off," and the hammer and the follower traveled down until the pile reached grade. It would have been impossible to have used an under-water hammer in this operation because so many piles had to be driven in a small area, and they were driven on a batter which put all of their heads practically together.

The swell caused by the driving in the dry holes was removed by eroding it with a high pressure water jet. A pulsometer was used for removing the eroded material. This method was necessarily used because there was no room for anyone to work between the piles or between the piles and the caisson. Where the holes could not be de-watered they were cleaned out with the airlift which did the work of the two pumps mentioned above. The holes were then sealed and when the seals were old enough the holes were pumped out, the piles cut off and the holes cleaned out again but this time with a jet and pulsometer.

Erection in three-span units

As mentioned before there were 39 continuous-girder units each of which consisted of three openings.

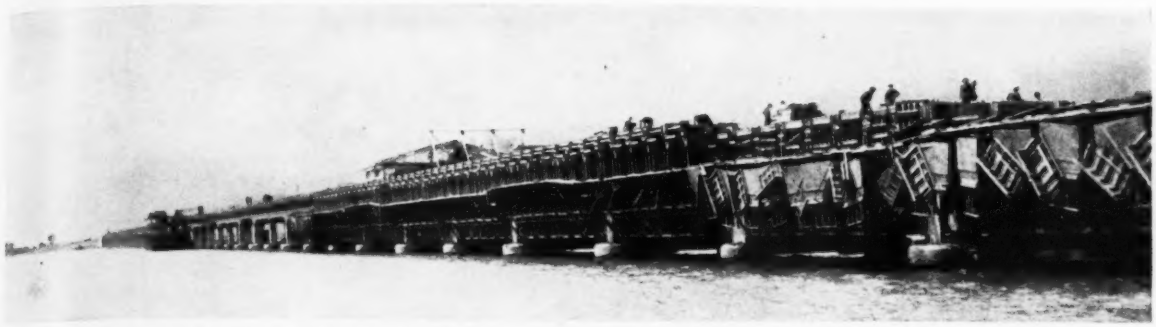


Fig. 3. Girder and deck concreting followed column construction in monolithic units of three spans, using steel truss centers and form units over and over for successive units.

These had to be poured monolithically so that three falsework spans were needed for each pour. Steel trusses were designed for this purpose and arranged so that they would be supported on the piers. Sand jacks were used between the shoes of the trusses and the piers, which made it possible to lower the trusses 6 in. With this clearance the trusses could be lowered onto barges to float them to another location.

The reinforcing steel was required to be welded. In each continuous girder of 3 spans there is about 150,000 lb. of bars. The bars for the main girders were assembled in templates in the material yard and welded into units. This was also done with the cross beam steel and with over half of the floor steel. This made it possible to do practically all fabricating and welding before the actual placing into forms started. With this fabricating done all steel for one bay could be placed in two days once the forms were set up.

The pouring of the concrete was a little unusual. A light steel truss spanned the entire roadway and sidewalks and traveled on wheels. On this truss there was a 1-yd. hopper that received the concrete and was moved from one side of the slab to the other by an air hoist. This enabled the concrete to be distributed anywhere that it was required on the slabs or walks with only three men. The finishing was done with a regular road finisher that had been extended to take care of a 40-ft. slab.

Contract is held by the Austin Bridge Co., Dallas, Tex., for which Jos. W. Grace is general superintendent, E. M. Philpot foundation superintendent and J. G. Nash superstructure superintendent. R. B. Alexander is resident engineer for the state on the job, and E. H. Edwards represents the PWA.

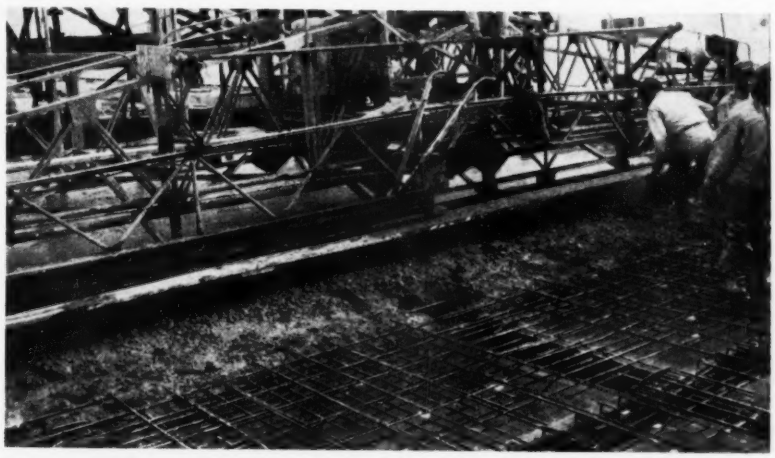


Fig. 4. Placing the deck slab which forms the paved roadway was done with a giant finishing machine having a span of 46 ft. between track wheels.

Fig. 5. Concreting is completed by pouring the railingposts in place to embed the ends of the precast concrete rails.

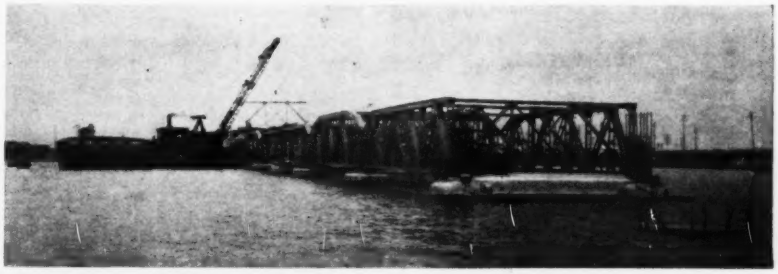


Fig. 6. Forms for the girders and decks were carried on steel truss spans set up in sets of three for one three-span continuous girder unit. Three sets of truss spans were used, being moved ahead alternately.

FIG. 1. SURFACE TREATMENT ON A STABILIZED-SOIL BASE IS FILLING ALABAMA WITH ROADS LIKE THIS

Earth Roads in the South–III

C. S. HILL

Associate Editor, *Engineering News-Record*

Alabama

On the theory that nature by weathering has sorted out the stable elements of local soils, Alabama is building an earth-road system

ALMOST as he enters the state the observer discovers that Alabama has a definite theory of earth-road construction. A visit with state highway department engineers and travel with them over recently built low-cost roads soon brings conviction of the utter belief in that theory. It stems obviously with H. H. Houk, chief engineer, who came over from the bridge department to direct Alabama's roadbuilding, but the sap of belief is in every branch of the engineering department. What is the theory? Definitely it is that the road is a structure and that earth is the best of roadbuilding materials.

Alabama has a large road mileage, an incessant traffic demand for all-weather roads and only a moderate amount of roadbuilding money. The only way to road-mileage needs is low-cost construction and the only way to this is to utilize the materials that are on or near the roads. Perhaps it might be said that here is where the theory roots but it would not express the full thought. Before developing this, however, let us get coordinated.

Main roads are earth

Alabama has state roads (6,500 mi.) and county roads (65,900 mi.) and administration is separate except where management is joined in three-way and two-way improvement, an administration device of which unique use has been made. It originated in the pressure in counties for faster main (state) road improvement. The state alone didn't have the road money for faster work. About that time (1935) the Alabama Relief Administration, later replaced by the WPA, entered the picture considering projects for work relief, and a division engineer of the state department, R. D. Jordan, conceived the idea of an equal partnership of state, county and relief administration for improving the needed roads. This was the three-way plan worked out in detail as described by James A. Baird of the state highway forces in *Engineering News-Record*, April 16, 1937, and it produced many hundreds of miles of new roads. Then the WPA faded out of the picture (they are now back in on a smaller scale) but the partnership idea had taken root and state and counties kept to it and went on in a partnership of two to develop the now active two-way plan.

Out of the three-way plan came something more than improved mileage gained; this was conviction of the permanency of roads of earth when properly designed and built, and accumulated skill in their construc-

tion. The theory of which we have spoken had an earlier origin without question but it was fixed in practice by the three-way plan.

A foundation first

Essentially the theory subordinates surfacing to foundation integrity. This does not mean that surface is neglected but that it is held that to be successful it must be placed on a stable subgrade or it must have an intermediate base or foundation that is stable enough to transfer surface load to the subgrade without distorting it. The correlative requirement is that the base thickness must be in proportion to the subgrade strength and the surface load. Ideally, the bearing power of the layers between the subgrade and the surface should increase from the allowable load on the subgrade to the wheel load on the surface and no sharp planes of discontinuity exist between layers of increasing bearing value. This not only makes for economy but impact effects are also minimized and riding comfort is increased.

With such a foundation the surface need be only a sound roofing and wearing course. Construction economy dictates the utmost use of the locally-available foundation materials, that is, as said before, the soils on or near the road. If these materials were of one kind and ready to use the problem would be simple; in Alabama they are of great variety: sands on the Gulf coast, limerock, clay-gravel, topsoil, chart, and up in the mountains limestone and a creek-bottom material known at float, a talus-like material in which are mixed clay and silt. All of these are good roadbuilding materials but all of each is not good—selecting, combining and processing are necessary.

Soil analysis next

A definite knowledge of the soils to be worked with is obviously a requirement of every roadbuilding operation and to meet it methods of intensive laboratory and field soils analysis and synthesis have been developed by J. L. Land, testing engineer. It perhaps is not far from the facts to say that in the soils laboratory and in the field tests directed by the laboratory lie sound reason for Alabama's very real success in making good roads of local materials. Investigation begins with the subgrade, and although it is less particular than that of the materials composing the base course, it is careful. Care and precision are emphasized in the analysis and synthesis of the base-course material.

For the most part improvement is on present road grades, most of them old. It is held essential that when line and grade permit, the old surface shall be left undisturbed on the theory that it has been weathered and consolidated under traffic to withstand destructive actions of nature better than will any new or reconstructed roadbed. This theory is even carried over to the construction of new grades. Soils that have shown ability to endure weather and the seasons over the years are left undisturbed where possible: they are checked by sampling and testing and surface disturbance is corrected by roller compaction and attention to moisture content, but they are chosen.

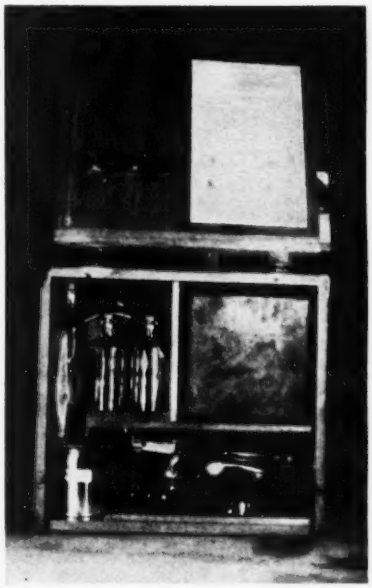


Fig. 2. (Top) Every job is provided with apparatus for testing soils in the field; full directions for making a field test are pasted on the inside lid. (Bottom) Sound soil from carefully tested pits is truck-hauled and truck-spread to be used alone or mixed with other soils to make a stable base.

It is the base-course materials that get the full attention of laboratory-control methods. These are necessarily disturbed materials and they are closely sampled and tested in the laboratory for gradation, clay, silt and sand content, plastic index and other properties that combine to make a naturally stable soil, and any required modifications are determined. It is not necessary to enlarge on details of laboratory procedure; they are such as the modern development of soils mechanics recognize, and they are carefully followed.

But there is one definite thought impressed on every soils operation which is that it is not to create a stable road material different than soils at hand but to select, proportion and mix suitable soils at hand so that a stable soil mixture is obtained. In Alabama practice a natural soil that is stable is laid down and compacted as it is; if the best soil economically available lacks some stabilizing element, that lack alone is supplied by adding another soil that will supply the necessary adjustments in the soil constituents, aggregate and binder. In Alabama practice it is held that generally the natural soils on or near the road contain all the elements required for stability, and that stability can be provided by simple combinations so that excursion abroad for stabilizing elements foreign to the common soils is uncalled for. Only with the prevailing shore sands along the Gulf coast are bituminous

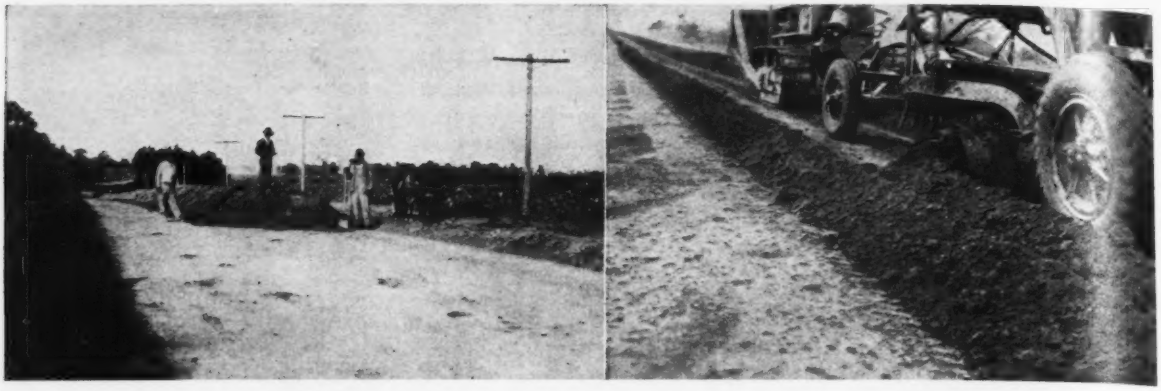


Fig. 3. Truck-hauled base material is placed on the prepared subgrade as shown and is then mixed and spread to base cross-section. Mixing is a blading and harrowing process; the disk harrow and the blade grader, both tractor-hauled, are typical equipment for mixing this material.

binders used, as in Florida. Emphasis is centered on natural stabilization. By doing this Alabama engineers believe that they are holding to fundamental principles in using earth for roads and simplifying the way of doing it. The proportioning of soil mixes is somewhat similar in principle to the proportioning of Portland cement or bituminous concrete mixes. Really, a soil concrete is found or designed and used.

In another article details of base soils and methods of base construction exemplifying practice in the south will be discussed. In Alabama it is the careful surface treatment that is impressive. To understand this the writer traveled and talked with Leon Gottlieb, the highway department bituminous engineer, and here are some of the things he pointed out:

Shaping the Base—When compacted, no base course is less than 6 in. thick, the surface has a straight-line crown of 1/3 in. per ft., and the shoulders have $\frac{3}{4}$ in. fall per foot. The base is compacted by traffic for 30 to 60 days or more depending on the base course material and the amount of traffic, number of layers in which the base is built and the rainfall or amount of sprinkling. For a smooth, even surface treatment it is necessary to have a very smoothly finished base. Every effort is exerted to shape and maintain the base and keep it true to profile grade and cross section from the time the base material is spread until the base is primed in order to secure and preserve traffic compaction. Only in case unforeseen conditions cause the base to become uneven is scarifying and reshaping permitted. Then, the procedure is to scarify the top lightly, not exceeding 2 in., push out to the sides all the material to the full depth of scarifier penetration, then wet the road and machine the loose material back over the surface. The wetting is continued and the surface is shaped to a true cross section.

Controlled traffic used

As soon as the proper shape is obtained the surface is rolled and controlled traffic is placed on it; multiple-wheeled pneumatic-tired rollers or loaded trucks under control are run over the road while the base course material has sufficient moisture to compact readily. The rolling will embed most of the larger size aggregate so that a smoother surface is obtained.

Priming the Base—After the base is compacted the dust is swept and blown from the surface and a prime coat is applied with a distributor at a rate of about 1/3 gal. per sq.yd. Alabama uses tar for the prime coat and usually under average summer weather conditions; grade TC 3 for most sand-clay and gravel bases; grade TC 4 where a very coarse sandy base is encountered, and for "tight" gravel, chert or top-soil-bound stone bases grade TC 2. In cooler weather tar about 5 to 10 points lower in viscosity is used for each type of base. If asphalt is used for the prime coat the average is grade MC 2 and the viscosity is varied depending on the porosity of the base and the weather conditions.

The prime coat is held essential for several reasons. It acts as a dust layer and helps bind the particles of fine aggregate on the surface. As the prime penetrates into the base, it helps stabilize the top part of the base and therefore adds from $\frac{1}{4}$ to $\frac{1}{2}$ in. to the structural element of the pavement. After the prime coat has been applied and traffic is permitted to use the road, it further compacts such semi-loose material as may be on the surface. The prime also serves as a binder for the succeeding bituminous application. Bituminous material will adhere much better to a primed base than to one which is not primed. Construction work can be carried on better and quicker when working on a primed base because it eliminates delays due to waiting for the base to be shaped or reshaped, and after rains the primed surface is dry and ready for surface mat construction much sooner than is unprimed base.

The Surface Mat—Forming the mat in surface treatment is the important work, says Mr. Gottlieb. His rules are terse and positive. The primed base must be dry and clean. Particles in the surface of the prime that would absorb the hot application should be scraped off. The temperature should be warm and not windy. To obtain best results there should be several weeks at least of hot weather after the mat application to allow traffic to embed the aggregate firmly in the bitumen before cool weather begins. The aggregate should be dry or the atmosphere such that it will dry the aggregate within one hour after it is spread on the road. The aggregate must be carefully spread so that it will completely cover the entire bituminous application, without leaving an excess to be rolled around and ground up under traffic. The aggregate must be hydrophobic, should be as nearly one size as prac-

ticable, and must be free from dust. The amount of bitumen should be such that the aggregate will adhere firmly to the base, provide a waterproof membrane next to the base and not be so excessive as to cause bleeding in a few months. The bituminous material should be applied at a uniform rate and at an average temperature not so hot that it will oxidize the bitumen nor so cold that it will chill too quickly.

Grade AC 10, which is 180 to 200 penetration asphalt, is used for the hot application; tar used should be grade TP 1, which has a consistency of 100 to 160 sec. in the float test at 122 deg. F. In cooler weather a softer material is used; up to about 300 penetration if asphalt, and for tar as soft as TH 1, which has a consistency of 150 sec. in the float test at 89.6 deg. F. The amount of bitumen used is around 0.42 gal. per sq.yd. depending on the character of the aggregate used.

The aggregate is spread immediately following the application of each distributor load of the bitumen by spreader boxes attached to the end gates of the trucks. After light brooming to obtain uniform coverage, the surface is rolled and controlled traffic is permitted on the road. Controlled traffic will embed the aggregate into the bitumen and thereby make a good mat. Fast traffic will dislodge and throw the aggregate to the shoulders in cool weather. Best results are obtained when the hot bitumen is covered with about ½ cu.ft. of aggregate per square yard. The tendency to continue matting into late October and November in order to finish during the season has caused the loss of several mats by "stripping."

The Seal Coat—The least expensive seal is another application of hot bituminous material covered with a smaller-sized aggregate. Another simple seal is the drag seal. The most successful work with this type is to allow traffic to use the first surface treatment for at least three weeks to one winter season. Then the treatment is cleaned and swept and 2/10 gal. per sq.yd. of grade RC 1 cut-back asphalt is applied and immediately covered with 1/5 cu.ft. per sq.yd. of fine aggregate. The moisture that may be in the aggregate is reduced by air drying. In not less than one hour a second coat of bitumen is applied on top of the aggregate so that the total of the first and second applications is between 0.42 and 0.45 gal. per sq.yd. Immediately following the second application the seal aggregate is dragged by a long-wheel-base broom drag, which accomplishes a road mixing of the aggregate and bitumen. Two or three rounds are necessary to coat the aggregate completely. As soon as the broom dragging is finished the surface is rolled. The next day about 6 lb. per sq.yd. (more if required) of local sand or stone screenings are spread over the surface and broomed lightly so as to ob-

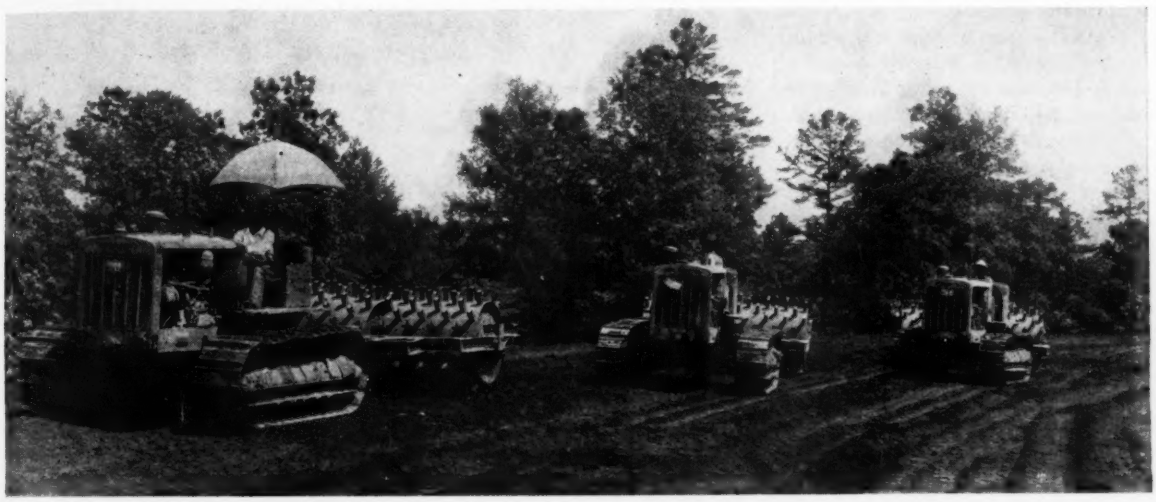


Fig. 4. Compacting the base is a vital operation; a tractor and sheepsfoot roller outfit is one of the striking sights observed.

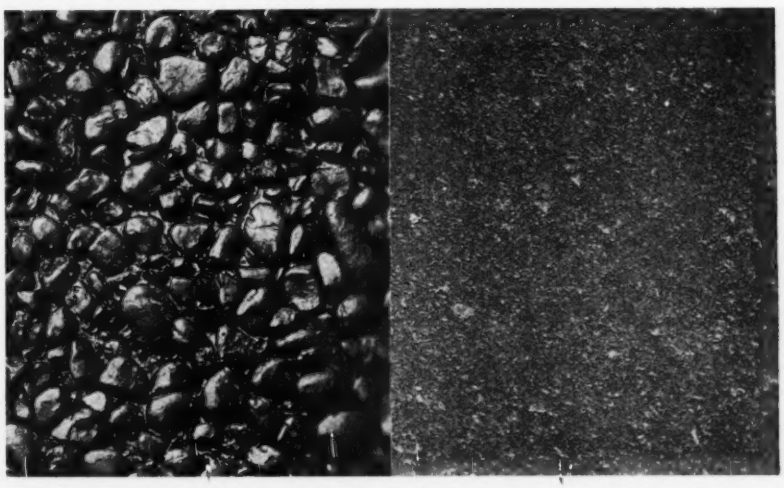


Fig. 5. Surface treatment is a refined process; at the left is seen the tack coat ready for the application of the seal coat and on the right is the final seal and finished surface.

tain uniform coverage. This brooming is conducted so as not to disturb the seal coal surface which has not as yet set up. As soon as the sand or screenings are spread and rolled the road is opened to traffic, although it is best to wait an additional day.

Alabama now uses premix material for the seal coal and to increase the production of aggregate, the stone or slag is allowed to have as much as 10 per cent passing the 16-mesh sieve, and to further reduce the cost this is often mixed with not more than 50 per cent local sand. The sand used is usually as coarse as concrete sand, but not as clean except when obtained from aggregate plants. The amount of sand used is reduced if the sand is finer. The premix was first made only in portable cold-patch mixers of 10 to 14 cu.ft. capacity, which is a unit about the size of a small concrete mixer, but now the premix also is produced commercially by large modern plants at all the principal aggregate supply points in the state. The batch is mixed between 1 min. and 2½ min. depending upon the amount of moisture in the aggregate. The aggregate is not dried in the small portable plants which only operate in dry weather. Large portable plants and commercial plants are equipped with driers.

In placing this seal, a tack coat of about 1/10 gal. of bituminous material per square yard is applied. Then the premixed material, when spread with patrol grader, is dumped from trucks in a windrow so as to place 30 lb. per sq.yd. The material is then spread uniformly over the surface by a long-base patrol grader and rolled, with a 5- to 7-ton roller. This 30 lb. of seal material fills the voids in the coarse aggregate surface treatment mat, almost covering all of the large aggregate, leaving a smooth non-skid surface of fine material. This season, practically all the premix seal has been placed with mechanical spreaders, working singly, spreading half-width at a time or in tandem covering the full pavement width. Excellent riding surfaces are obtained, indistinguishable from the best in bituminous concrete and at no greater cost than patrol spreading, although 35 to 40 lb. are necessary to enable the spreader bar to pass over projecting coarse aggregate. At present this type of seal appears to give the best results in Alabama.

In commenting on this surfacing Chief Engineer H. H. Houk said: "The design is inherently stable and flexible. The uniform size particles in the coarse aggregate layer deliver the traffic wheel loads directly to the base course without transmission from particle to particle or any movement of aggregate on aggregate. The aggregate is embedded in a heavy elastic layer of bitumen that penetrates the top of the base course and is an integral part of it. The single layer itself is weather-proof and if the maximum particle size is held to ¾ in. or less it has been used as a single course wearing surface for years without need for a bituminous seal coat."

The cost of the last 1,500,000 sq.yd. of surface course prime, mat and seal let to contract on federal-aid projects averaged slightly less than 25c. per sq.yd.

Skipping one week to give our readers an account of the planning, design and construction of the New York World's Fair in one full issue, the next article of this series will take the survey of earth roads in the South to Georgia. In this state are found and used most of the varieties of road base soils that southern road engineers use in natural stabilization.

Retaining Wall Design Charts

L. T. WATERMAN
Engineer, Farm Security Administration, Marion, Ill.

While not replacing formulas these charts will speed up the checking of design drawings for various types of retaining walls

THE CHART for computation of horizontal load is based on Rankine's theory of earth pressure. The remainder of the charts in Figs. 1 and 2 are based on standard steel-design formulas. Minimum spacing of bars is based on a ¾-in. aggregate and sufficient area between the bars to carry the shear transferred by the portion of the bars below the minimum section of concrete. The portions of the charts dealing with minimum spacing and maximum size of reinforcing bars are introduced for use in simple beam design.

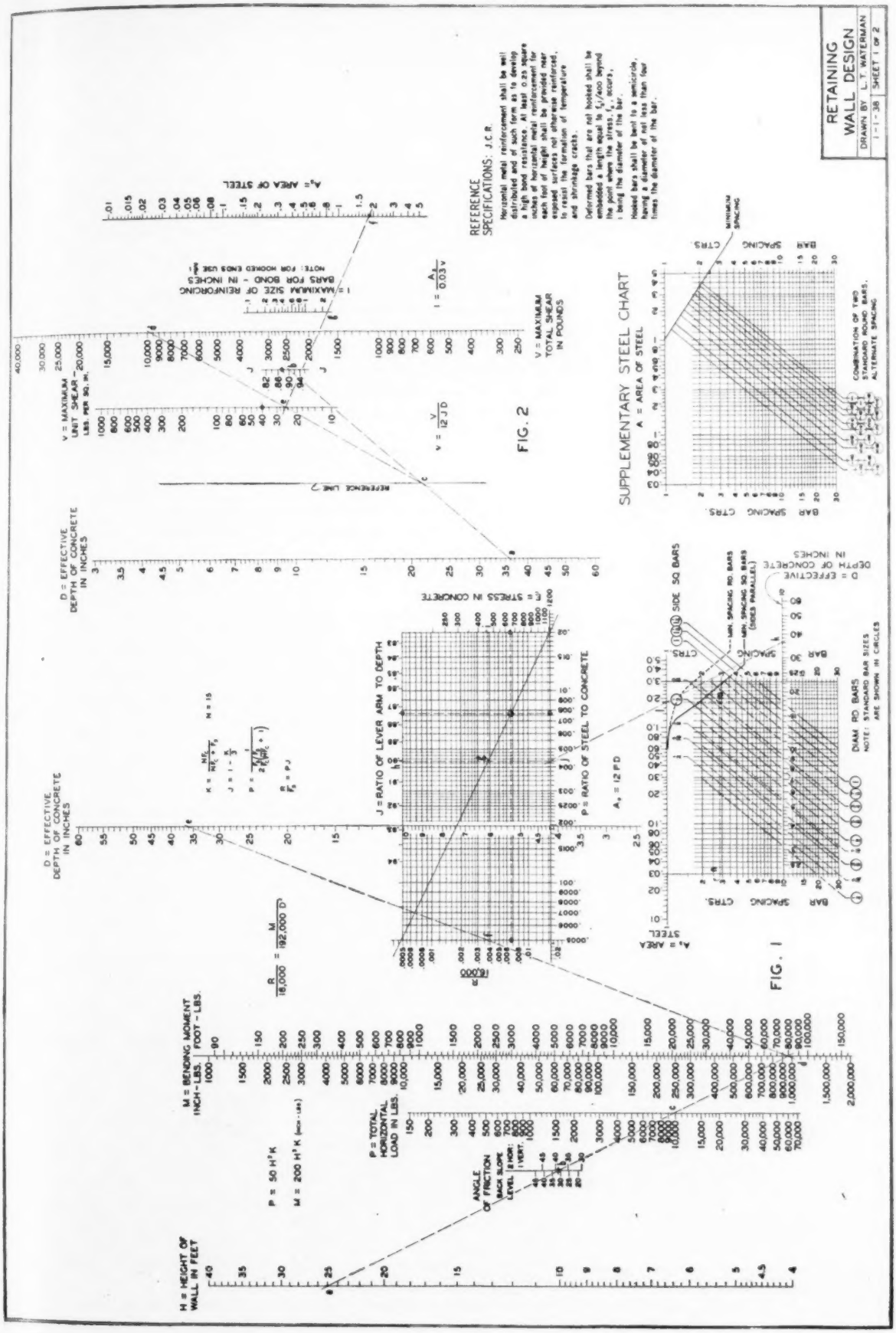
Procedure for stem

Determine the height of the wall. Then assume the earth loading conditions from observations in the field as needed on the chart, Fig. 1. Interpolate for backslopes not shown. Draw the straight line *a b c d* through the height of wall at *a* and angle of friction at *b*. Read off the values of horizontal load at *c* and bending moment at *d*. Assume a value for the effective depth of concrete depending upon the concrete unit stress desired. Draw the line *d e f* through the bending moment at *d* and the effective depth of concrete at *e*. Read off the value of R/16,000 at *f*. If another value of F_s is preferred, multiply R/16,000 by the ratio $16{,}000/F_s$, and transfer to the new value of *f* on the same scale before proceeding. Through *f* draw a horizontal line to intersect the diagonal at *g*.

Draw a vertical line through *g* to intersect the steel-concrete ratio at *j;* Draw the line *j k l* through the steel-concrete ratio at *j* and the effective depth of concrete at *k*. Read off the value of required steel area per foot of slab width at *l*. Draw a vertical line through the required steel area to intersect all the available steel bar diagonals. Choose a bar such as *m*. Then draw a horizontal line to intersect the bar-spacing scale, and choose a convenient spacing as *n*. If the desired bar size and spacing is not obtained in the first trial, assume another value for the effective depth of concrete, and repeat the procedure.

For the reduction in steel toward the top, plot the steel area required against the distance from the top by placing the distance from the top equal to height of wall.

Use Fig. 2 to check the maximum unit shearing stress. Draw the line


RETAINING WALL DESIGN
DRAWN BY L.T. WATERMAN
1-1-38
SHEET 1 OF 2
REFERENCE SPECIFICATIONS: J.C.P.
Horizontal metal reinforcement shall be well distributed and of such form as to develop a high bond resistance. At least 0.25 square inches of horizontal metal reinforcement for each foot of height shall be provided near exposed surfaces not otherwise reinforced, to resist the formation of temperature and shrinkage cracks.
Deformed bars that are not hooked shall be embedded a length equal to f_s/400 beyond the point where the stress f_s occurs, i being the diameter of the bar.
Hooked bars shall be bent to a semicircle, having a diameter of not less than four times the diameter of the bar.
FIG. 2
FIG. 1
SUPPLEMENTARY STEEL CHART
A = AREA OF STEEL
BAR SPACING CTRS.
COMBINATION OF TWO STANDARD ROUND BARS, ALTERNATE SPACING
MINIMUM SPACING
D = EFFECTIVE DEPTH OF CONCRETE IN INCHES
V = MAXIMUM TOTAL SHEAR IN POUNDS
v = MAXIMUM UNIT SHEAR — LBS. PER SQ. IN.
v = V / 12 JD
i = A / 0.03 v
i = MAXIMUM SIZE OF REINFORCING BARS FOR BOND - IN INCHES
NOTE: FOR HOOKED ENDS USE 1.5 i
A_s = AREA OF STEEL
J = RATIO OF LEVER ARM TO DEPTH
K = N f_s / (N f_s + f_c)
J = 1 - k/3
p = 1 / (2(N/k - 1))
f_s / f_c = pJ
N = 15
f_s = STRESS IN CONCRETE
p = RATIO OF STEEL TO CONCRETE
A_s = 12 p D
SIDE SQ BARS
MIN. SPACING RD. BARS
MIN. SPACING SQ. BARS (SIDES PARALLEL)
DIAM. RD. BARS
NOTE: STANDARD BAR SIZES ARE SHOWN IN CIRCLES
R / 18,000 = M / 192,000 D²
M = BENDING MOMENT INCH-LBS. FOOT-LBS.
P = TOTAL HORIZONTAL LOAD IN LBS.
P = 50 H² K
M = 200 H³ K
ANGLE OF FRICTION
BACK SLOPE LEVEL
2 HOR. : 1 VERT.
H = HEIGHT OF WALL IN FEET

RETAINING WALL DESIGN
DRAWN BY L. T. WATERMAN
1-3-38 SHEET 2 of 2

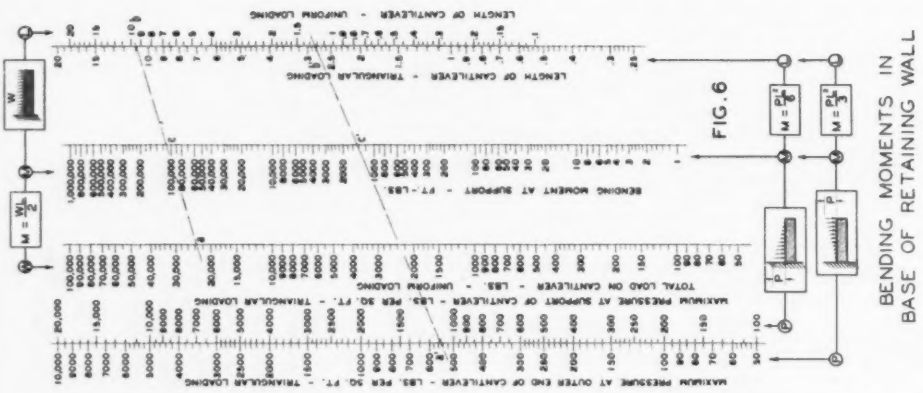

LENGTH OF CANTILEVER - UNIFORM LOADING
LENGTH OF CANTILEVER - TRIANGULAR LOADING
BENDING MOMENT AT SUPPORT - FT.-LBS.
TOTAL LOAD ON CANTILEVER - LBS. - UNIFORM LOADING
MAXIMUM PRESSURE AT SUPPORT OF CANTILEVER - LBS. PER SQ. FT. - TRIANGULAR LOADING
MAXIMUM PRESSURE AT OUTER END OF CANTILEVER - LBS. PER SQ. FT. - TRIANGULAR LOADING
W
M = W l/2
M = P l²/6
M = P l²/3
P
P
A
B

FIG. 6

BENDING MOMENTS IN BASE OF RETAINING WALL

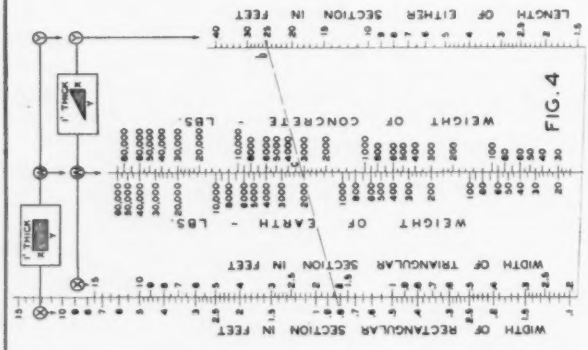

LENGTH OF EITHER SECTION IN FEET
WEIGHT OF CONCRETE - LBS.
WEIGHT OF EARTH - LBS.
WIDTH OF TRIANGULAR SECTION IN FEET
WIDTH OF RECTANGULAR SECTION IN FEET
1' THICK
1' THICK

FIG. 4

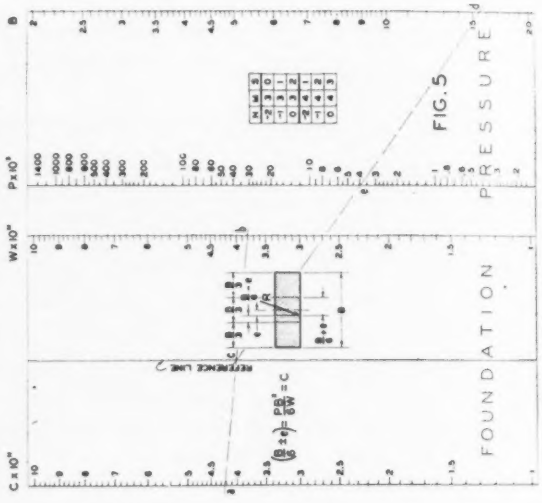


FIG. 5

REFERENCE SPECIFICATIONS: J.C.R.

Unit stresses in the heel shall not exceed ⅓ the design stresses, if the foundation pressure is neglected.

Exposed faces of wall shall preferably be given a batter of not less than ½" in 12".

Provision for temperature change shall be made by grooved lock joints spaced not over 60 feet apart.

Drains or "weep holes" not less than 4 inches in diameter and not more than 10 feet apart, shall be provided.

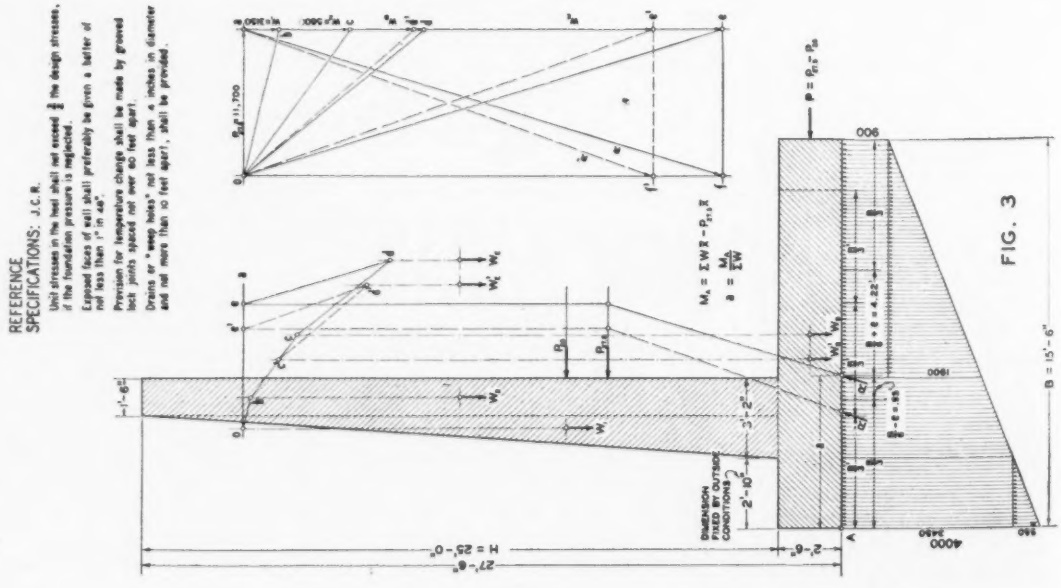


FIG. 3

POSITION OF RESULTANT

a b c through the effective depth of concrete at *a* and the value of *f* found in Fig. 1. Connect the intersection at *c* on the reference line with the value of total shear at *d* by the line *c d e*. The total shear is equal to the total horizontal load found in Fig. 1. Read off the value of maximum unit shear at *e*.

For preliminary design against overturning, sliding and base pressure, graphical method Fig. 3 is suggested. The top dimension is assumed as ½ ft. and the base thickness as 2½ ft. To design the base so that the toe or heel does not extend beyond a certain point in reference to the stem, the fixed point *A* may be chosen at any point along the bottom of the base.

Procedure for base

For the first trial, assume the base length equal to 13½ ft. Find the weight of each triangular and rectangular section of the concrete and earth acting on the foundation from Fig. 4. With the weights found, draw a force polygon such as in Fig. 3. Determine the location of the resultant by a funicular polygon similar to the one shown at the top of the stem. In the first trial, the resultant is slightly inside the middle third of the base. Measure the distance from the resultant to the third points along the bottom of the base. Enter Fig. 5 with these values to obtain the base pressure. Follow the letters in alphabetical order to the base pressure line. Determine the location of the decimal point by the table showing the exponential relations. Since, in the first trial, the base pressure exceeds 4,000 lb. per sq.ft., assumed to be the allowable in this case, repeat the above procedure until the desired pressure is obtained.

Represent the base pressure graphically, and divide it into triangular and rectangular loadings. Use Fig. 6 to determine the moments in the base. The two examples given are those of the earth load *a b c* acting on the heel, and the triangular portion of the base pressure *a' b' c'* acting on the toe. Obtain the bending moments separately for each loading condition by the chart, Fig. 6, and add algebraically. To find the steel required, substitute the total moments in Fig. 1, and proceed the same as for the stem.

Bituminous Enamel Bond Strength

O. G. GOLDMAN

Assistant Superintendent, San Francisco Water Department

A device for accurately determining bond strength used to determine cause of bond of pipe coatings

BEGINNING with the introduction of spinning as a means of applying protective coatings of bituminous enamel to the surfaces of steel pipe, a need arose for some means of determining the strength of the bond between enamel and steel. This need was emphasized a few years ago when an enamel coating was found to have slipped in large sheets from its place on steel water pipes stored in the stock yard awaiting installation by the San Francisco Water Department. Because the cause of failure of the protective coating must be established before remedy could be prescribed, an endeavor was made to find some means of making accurate test of the bond developed between steel and enamel under various conditions and combinations of moisture, temperature, period of application, etc. These requirements were met when the device described in the following was developed and used in analyzing the causes of trouble with bituminous coating.

Defects causing inadequate bond in protective enamel coatings might arise from one or more of several conditions: (1) primer coat not dry enough, (2) primer coat too dry; (3) insufficient adhesion between primer coat and enamel and (4) atmospheric temperature high enough to soften primer coat or enamel, or both. If the fourth cause obtained, adhesion between steel and enamel could be overcome by the force of gravity.

Where failure results from excessive wetness or over-dryness of the primer coat, some definite degree of dryness should produce a maximum bond. If the failure cause is in adhesion, then increased temperatures at the time of application should solve the problem. Should the cause of failure be solely high air temperature, then some method should be found for protecting the finished pipe during manufacture, storing, transportation and installation.

The device developed by the writer for making determinations of bond

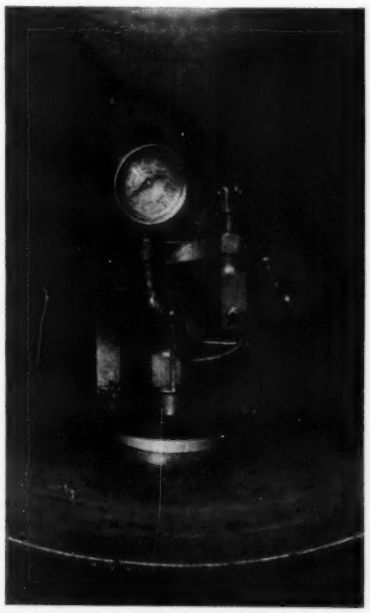


Fig. 1. The bond testing device set up inside a 36-in. water main. The disk on which the instrument rests is shaped to fit the pipe.

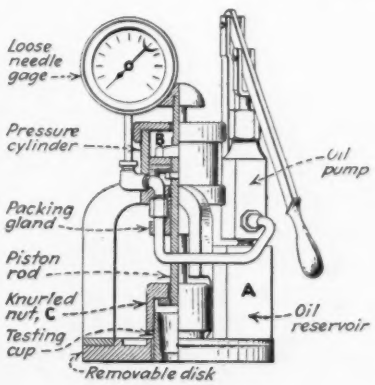


Fig. 2. Sectional view of bond-testing device showing essential working parts.

strength consists, essentially, of a cylinder mounted on a metal frame, a piston within the cylinder and a piston rod extending downward through a packing gland (Fig. 2). Attached to the metal frame is a small oil reservoir (*A*) and a plunger pump by which oil can be pumped into the cylinder (*B*). A loose-needle gage is attached to the oil pressure line to record the maximum oil pressure developed. The metal frame rests loosely upon a disk machined to fit the pipe curvature (either inside or outside), and the disk has an open circular section at its center to receive testing cups. These cups can be attached to the lower end of the piston rod by means of a knurled nut (*C*).

The method of using this instrument is as follows: a coal tar primer is applied to the steel surface to be enameled and is permitted to dry. The proper degree of dryness is determined by setting the test cups over the primer after different periods of drying and filling the cups with molten enamel. When the enamel in the cups has cooled to air temperature the testing device is set up over a cup, which is then attached to piston rod by means of the knurled nut. Oil is then pumped into the cylinder until the pressure is sufficient to pull the test cup from the surface. The pressure required is recorded by the gage needle.

Increase in the gage reading with increase of drying time indicates that more drying time for the primer coat is needed. Decrease in gage readings indicates that the primer coat is too dry. In between these periods of drying there is a point where the pull required for removing the test cups is fairly uniform. This represents the proper drying time and it is this drying period that should be prescribed before applying enamel to the pipe sections.

When the proper drying of the primer coat and enameling times have been determined, it will be found that the enamel will always break in the test cups, and the readings obtained on the pressure gage will be the tensile strength of the enamel itself, which, of course, is the maximum result obtainable.

If tests as described in the foregoing do not cause the enamel to break in the test cups, irrespective of the primer coat drying time, but instead, the separation is between primer and enamel, the indication is that cohesive bond between primer and enamel is faulty and that one or the other must be applied at a higher temperature.

By a series of tests made on test plate of metal similar to that to be enameled, the proper drying time can be established in advance and the manufacturer can be given material assistance in meeting specifications.

Where extreme temperature is to be studied in connection with bond strength, the procedure can be simplified by carrying out the tests under water. The temperature of a water bath can be varied and controlled more uniformly than can air temperature. Hence, for tests where temperature is the variable to be compared, the test cups are set in place on the metal and the specimen is immersed in a water bath: the water temperature then is raised to any desired figure, and after all parts have reached uniform temperature several test cups are pulled. This process can be repeated at increased temperatures until a definite relation between bond strength and temperature over a satisfactory range has been established.

The device can be used equally well on test specimens or on the enamel already applied to pipes ready for service. The procedure is the same as on test specimens except that an "island" is first cut in the enamel by a tool which cuts a groove ¼ in. wide to isolate the portion on which the testing cup is to exert its pull.

Patented application on the bond testing device has been made.

Attempts to Solve Parking Problem

THE GROWING TRAFFIC crush on the downtown streets of American cities leads to a distinct municipal trend to use undeveloped or vacant land near central business districts for off-street parking, according to a joint study of the American Society of Planning Officials and the International City Managers' Association.

Many cities have attempted to alleviate the problem by setting up municipally-owned or -operated parking lots; others by seeking to stimulate privately-owned parking lots. Cities encourage private operation of parking space by leasing city land to private interests, enforcement of time limits and parking prohibition regulations in congested areas, changes in zoning regulations on land used in certain areas, and in the use of buildings as parking garages, encouraging property owners to demolish obsolete buildings or causing such buildings to be removed by city agencies.

This study shows that virtually all cities of more than 25,000 population have one or more privately-owned or -operated parking lots in the central business district. Los Angeles probably has the largest off-street parking facilities, with 652 parking lots and garages accommodating 56,000 automobiles. Detroit is second with 280 parking lots providing off-street space for 22,765 cars; Rochester has 210 parking lots for 15,218 cars; Minneapolis, 100 parking lots for 9,000 cars; Boston, 159 parking lots for 7,500 cars; Cincinnati, 53 lots for 5,274 cars; Dayton, 35 lots for 3,460 cars, and Louisville, 53 lots for 4,331 cars.

A study of 23 cities between 100,000 and 200,000 shows that parking lots range from three in Fall River, Mass., to 125 in Hartford, Conn., and Nashville, Tenn., with five other cities having more than 50 parking lots in the downtown sections.